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Development Canada

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pour la défense Canada



DRDC Suffield Soil Laboratory Program

Progress Report – Piston and Onager Sites

J. Barchard and A. Kupper
AMEC Earth & Environmental Limited

Contract Scientific Authority: S.L. Hlady
Defence R&D Canada – Suffield

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Contract Report
DRDC Suffield CR 2004-112
January 2004

Canada

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14. ABSTRACT AMEC Earth & Environmental Limited (AMEC) was retained by Defence Research & Development Canada (DRDC) Suffield to carry out laboratory testing on soil samples from prairie soil samples from the Mine Effects Site near Building 148 on the Experimental Proving Ground at DRDC Suffield. AMEC's geotechnical laboratory in Edmonton, Alberta received three large, bag soil samples in late October 2003 for DRDC's Piston, Onager East and Onager West sites. The following laboratory tests were requested by DRDC 1. • Determination of water content of soil samples 2. • Preparation of compacted samples in range of natural water contents 3. • Consolidation tests using ASTM D2435 on two samples; and 4. • Triaxial undrained tests (CUP) using ASTM D4767 on three samples. A typical range of natural water contents of 13 to 19 percent was provided to AMEC by DRDC Suffield for similar soil at these sites. For testing, compacted samples were prepared at water contents within the natural water content range, with target water contents of approximately 15 percent. Results are provided according to American Standard Testing Methods (ASTM) standards where applicable. Results for the Triaxial undrained tests (CUP) using ASTM D4767 on three samples are provided in CR 2004-138, DRDC Soil Laboratory Program Triaxial Test Results - Onager Site.					
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16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES 34	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

DRDC Suffield Soil Laboratory Program

Progress Report – Piston and Onager Sites

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Contract Number: W7702-03-R527

Contract Scientific Authority: S.L. Hlady (403-544-4727)

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Defence R&D Canada – Suffield

Contract Report
DRDC Suffield CR 2004-112

Abstract

AMEC Earth & Environmental Limited (AMEC) was retained by Defence Research & Development Canada (DRDC) Suffield to carry out laboratory testing on soil samples from prairie soil samples from the Mine Effects Site near Building 148 on the Experimental Proving Ground at DRDC Suffield. AMEC's geotechnical laboratory in Edmonton, Alberta received three large, bag soil samples in late October 2003 for DRDC's Piston, Onager East and Onager West sites.

The following laboratory tests were requested by DRDC:

1. · Determination of water content of soil samples;
2. · Preparation of compacted samples in range of natural water contents;
3. · Consolidation tests using ASTM D2435 on two samples; and
4. · Triaxial undrained tests (CUP) using ASTM D4767 on three samples.

A typical range of natural water contents of 13 to 19 percent was provided to AMEC by DRDC Suffield for similar soil at these sites. For testing, compacted samples were prepared at water contents within the natural water content range, with target water contents of approximately 15 percent.

Results are provided according to American Standard Testing Methods (ASTM) standards where applicable. Results for the Triaxial undrained tests (CUP) using ASTM D4767 on three samples are provided in CR 2004-138, DRDC Soil Laboratory Program Triaxial Test Results – Onager Site.



10 December 2003
BX02777

Defence R&D Canada - Suffield
PO Box 4000, Stn Main
Medicine Hat, AB T1A 8K6

Attention: Ms. Sheri Hlady, Defence Scientist

Dear Ms. Hlady,

**Re: DRDC - Suffield
Soil Laboratory Program - Progress Report
Piston and Onager Sites**

1.0 INTRODUCTION

AMEC Earth & Environmental Limited (AMEC) was retained by Defence Research & Development Canada (DRDC) Suffield to carry out laboratory testing on soil samples from research sites at or near their Suffield operation. A summary of the testing completed to date is provided below.

2.0 LABORATORY TEST PROGRAM

AMEC's geotechnical laboratory in Edmonton, Alberta received three large, bag soil samples in late October 2003 for DRDC's Piston, Onager East and Onager West sites. The following laboratory tests were requested by DRDC:

- Determination of water content of soil samples;
- Preparation of compacted samples in range of natural water contents;
- Consolidation tests using ASTM D2435 on two samples; and
- Triaxial undrained tests (CUP) using ASTM D4767 on three samples.

A typical range of natural water contents of 13 to 19 percent was provided to AMEC by DRDC for similar soil at these sites. For testing, compacted samples were prepared at water contents within the natural water content range, with target water contents of approximately 15 percent. All testing is completed to date, with the exception of the triaxial tests, which are currently in progress. Results are provided according to American Standard Testing Methods (ASTM) standards where applicable.

2.1. AVAILABLE RESULTS

2.1.1. Water Content

All three samples received were described based on visual examination. The sample from the Piston site was described as a clayey, low plastic, brown silt with interbedded clay layers and coal fragments up to 10 mm in size, while the soil samples from the Onager site were described as a sandy, silty, low plastic, brown clay, containing roots. The water contents of the samples were found to generally range between 6 to 8 percent, and were as low as 3.3 percent, all of which are lower than the natural water content range provided by DRDC. Laboratory results of the water contents tests on each sample are attached.

2.1.2. Compacted Samples

The water content results were reported to DRDC by Email on 31 October 2003 and DRDC requested that the soil samples be prepared to a water content within the natural water content range i.e. approximately 15 percent. Compacted samples were then prepared for each site and the wet and dry densities were determined for the water content of the compacted samples. This test is referred to as a "One Point Proctor Test". This information was then used in preparing the samples for consolidation and triaxial testing. Results of the One Point Proctor Tests are provided in Table 1 below.

Table 1.: One Point Proctor Test Results

Sample	Water Content (%)	Wet Density (kg/m³)	Dry Density (kg/m³)
Piston Site	14.2	1852.1	1621.8
Onager Site East	13.4	1823.6	1608.1
Onager Site West	15.3	1780.5	1544.0

2.1.3. Consolidation Tests

Consolidation tests were performed on a compacted sample from the Piston site and a combined compacted sample from the Onager East and West sites, as requested by DRDC. Testing was completed according to ASTM D2435-90, Test Method B with incremental loading and rebound (unloading). Results from the consolidation tests are attached. Note that as the samples were prepared by remolding and compacting the soil in the laboratory, the pre-consolidation pressure provided does not necessarily reflect the in-situ (on site) condition of the soil.

2.2. PROGRESS ON TRIAXIAL TESTS

Samples were prepared from each of the three sites for triaxial testing and testing is currently in progress. The time required to complete these tests depends on the behaviour of the soil during testing and an approximate completion date is late December 2003. Based on this,



results should be available in early January 2004 and will be reported as soon as they are available.

3.0 CLOSURE

We trust that the results of the testing completed to date provide the intended soil properties from the laboratory test program. If there were further testing required or that you would like to discuss, AMEC would be pleased to assist DRDC.

Should you have any questions or comments please contact the undersigned.

Respectfully submitted,

AMEC Earth & Environmental Limited

Ja'net Barchard, M.Sc., EIT

Angela Kupper, Ph.D., P.Eng
Senior Geotechnical Engineer



Project No.

BX02777

Lab No.

0

Technician

LK

Date

October 30, 2003

MOISTURE CONTENT WORKSHEET

Hole No.	Piston #1	Piston #2				
Depth						
	Record Tare Weight (zero or actual weight)					
Wt. Sample Wet + Tare	242.35	331.05				
Wt. Sample Dry + Tare	228.36	310.37				
Wt. Water	13.99	20.68				
Tare Container	0.00	0.00				
Wt. Dry Sample	228.36	310.37				
Moisture Content %	6.1	6.7				
Hole No.	Onager #1	Onager #2	Onager #3	Onager #4		
Depth						
Tare No.	Record Tare Weight (zero or actual weight)					
Wt. Sample Wet + Tare	182.63	154.05	344.33	187.22		
Wt. Sample Dry + Tare	169.51	149.09	324.42	174.47		
Wt. Water	13.12	4.96	19.91	12.75		
Tare Container	0.00	0.00	0.00	0.00		
Wt. Dry Sample	169.51	149.09	324.42	174.47		
Moisture Content %	7.7	3.3	6.1	7.3		
Hole No.						
Depth						
Tare No.	Record Tare Weight (zero or actual weight)					
Wt. Sample Wet + Tare						
Wt. Sample Dry + Tare						
Wt. Water						
Tare Container						
Wt. Dry Sample						
Moisture Content %						
Hole No.						
Depth						
Tare No.	Record Tare Weight (zero or actual weight)					
Wt. Sample Wet + Tare						
Wt. Sample Dry + Tare						
Wt. Water						
Tare Container						
Wt. Dry Sample						
Moisture Content %						
Hole No.						
Depth						
Tare No.	Record Tare Weight (zero or actual weight)					
Wt. Sample Wet + Tare						
Wt. Sample Dry + Tare						
Wt. Water						
Tare Container						
Wt. Dry Sample						
Moisture Content %						

AMEC EARTH & ENVIRONMENTAL LIMITED

ONE-DIMENSIONAL CONSOLIDATION TEST (ASTM D2435-90)

Project	Defence Research Development Canada		
Test	Test Method B (Remolded & Compacted Sample)		
Location	Medicine Hat		
Job No.	BX02777	Sample No.	Machine # 1
Hole No.	Piston Site	Depth (m)	-
Technician	LK	Date Started	06/11/2003

Apparatus Data

Moisture Content Data

Ring No.	#1		Wt. of Ring + Soil + Water (Start)	215.20	g
Weight of ring	80.34	g	Wt. of Ring + Soil + Water (End)	233.60	g
Thickness	18.974	mm	Wt. of Ring	80.34	g
Diameter	70.053	mm	Wt. of Soil + Water (End)	233.60	g
Area	38.543	cm ²	Wt. of Tare (Tare #)	14.70	g
Machine No.	#1		Wt. of Soil Dry + Tare	212.50	g
Loading Beam Ratio	11:01		Wt. of Soil	117.46	g
Weight of Top + Stone	0.575	kg			

Specimen Data

Initial	Final
---------	-------

Index Tests

CalculatedFinal

Specimen Height	18.9740	16.855	mm	Specific Gravity (Assumed)	2.68	
Volume of Specimen	73.13	64.96	ml			
Volume of Solids	43.83	43.83	ml			
Volume of Voids	29.30	21.14	ml			
Volume of Water	17.40	21.10	ml			
Void Ratio	0.669	0.482				
Saturation	59	100	%			
Moisture Content	14.8	18.0	%	Soil Description	Silt, clayey, low plastic, interbedded Cl layers, coal frags to 10mm.	
Height of Solids	11.37	11.37	mm			

Soil Description

Silt, clayey, low plastic, interbedded CI layers, coal frags to 10mm.

Swelling Pressure P_s

46.8	kPa
------	-----

Pre-Consolidation Pressure P_o'

400	kPa
-----	-----

Pressure
p
(kPa)

Dial
Reading
(mm)

Apparatus
Deformation
(mm)

Corrected
Height
(mm)

Strain
 ϵ
(%)

Void Ratio
 e

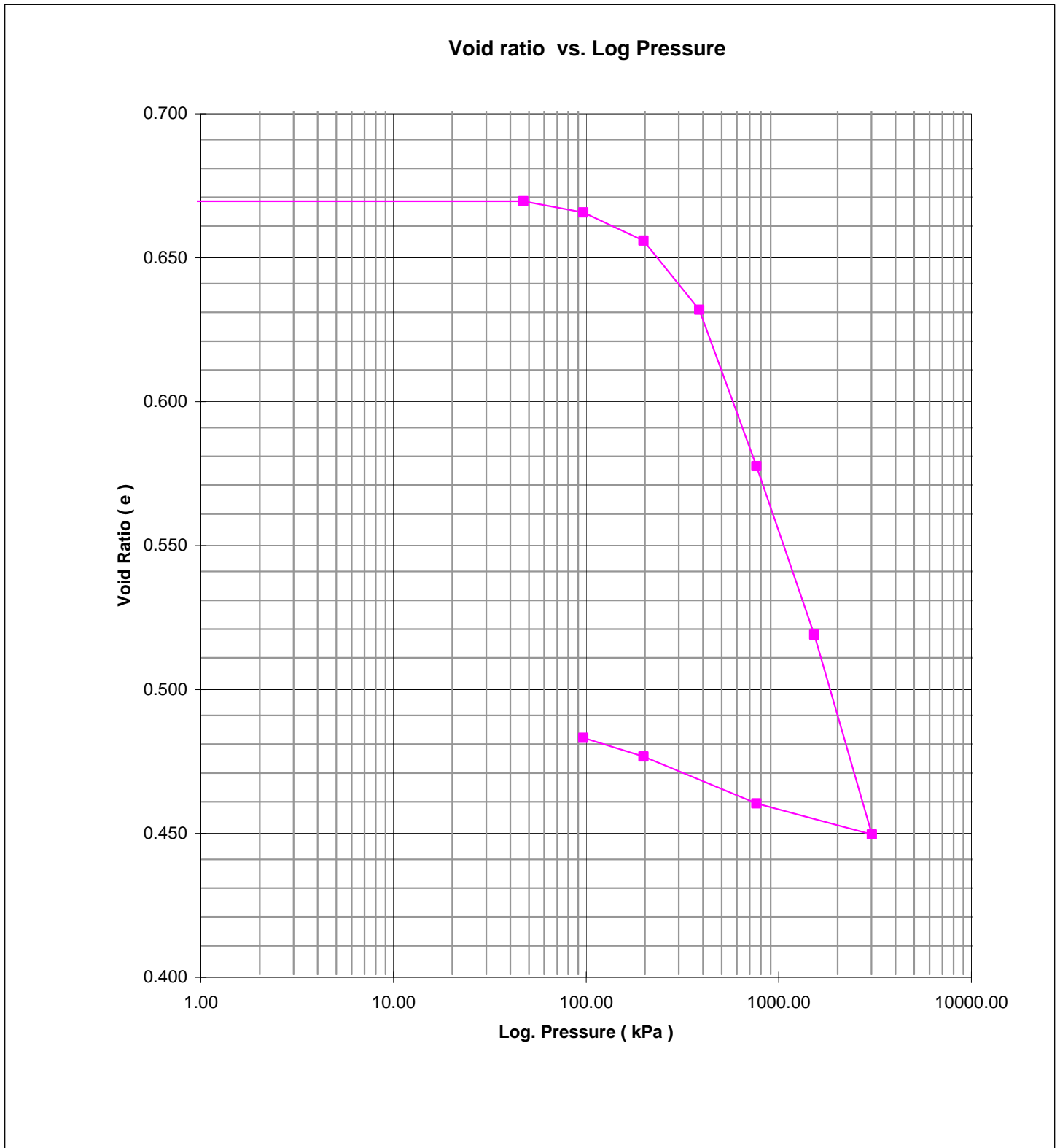
Modulus
 $E = \Delta p / \Delta \epsilon$
(MPa)

$$C_v$$

(m²/yr)
$$m_v$$

(m^2/MN)[illegible]

AMEC EARTH & ENVIRONMENTAL LIMITED <i>Engineering & Environmental Services</i> <i>Edmonton, Alberta, Canada</i> ONE-DIMENSIONAL CONSOLIDATION TEST (ASTM D2435-90)	Project	Defence Research Development Canada		
	Test	Test Method B (Remolded & Compacted Sample)		
	Location	Medicine Hat		
	Job No.	BX02777	Sample No.	Machine # 1
	Hole No.	Piston Site	Depth (m)	-
	Technician	LK	Date Started	06/11/2003

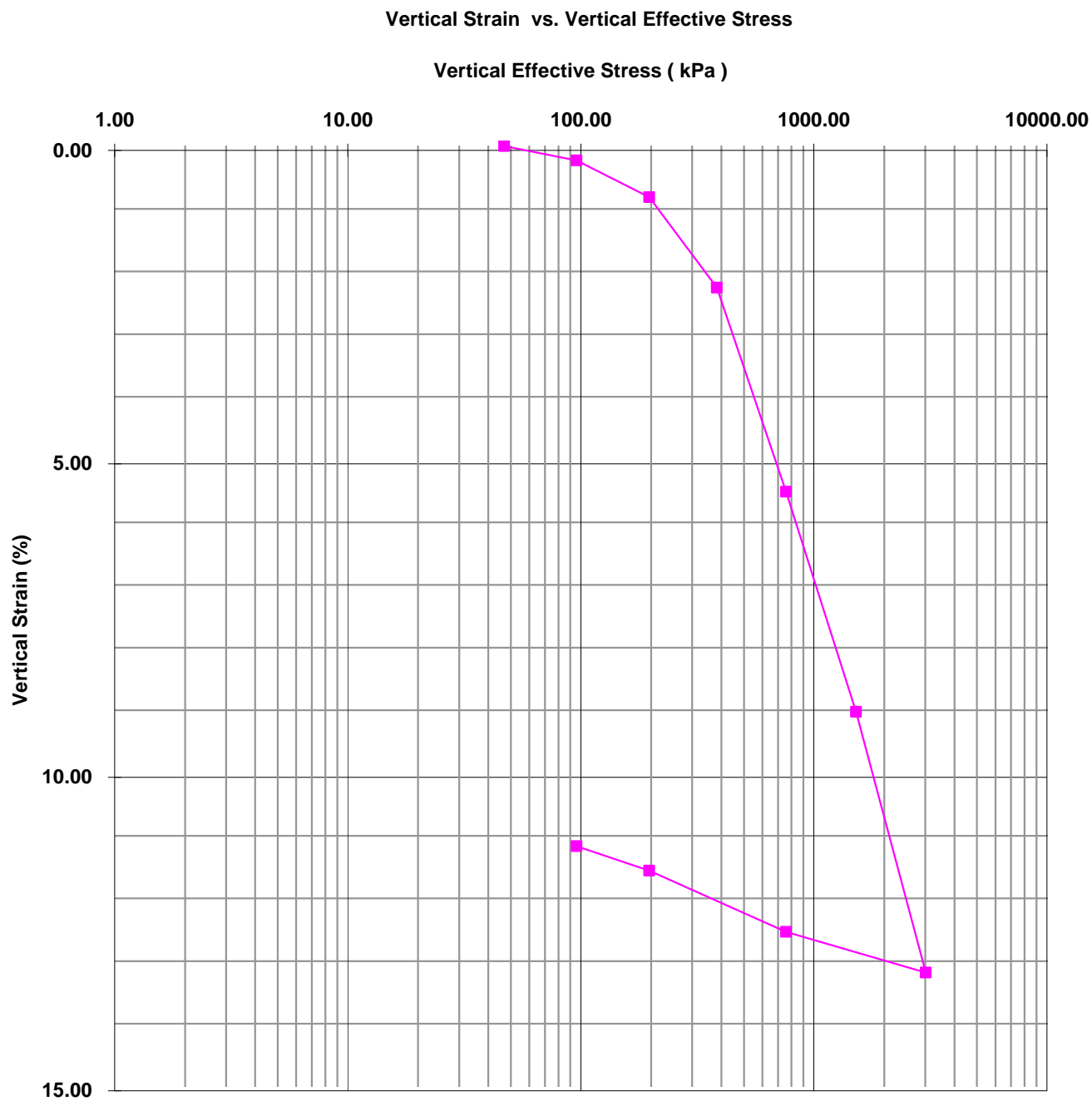


AMEC EARTH & ENVIRONMENTAL LIMITED

Engineering & Environmental Services
Edmonton, Alberta, Canada

ONE-DIMENSIONAL CONSOLIDATION TEST
(ASTM D2435-90)

Project	Defence Research Development Canada		
Test	Test Method B (Remolded & Compacted Sample)		
Location	Medicine Hat		
Job No.	BX02777	Sample No.	Machine # 1
Hole No.	Piston Site	Depth (m)	-
Technician	LK	Date Started	06/11/2003

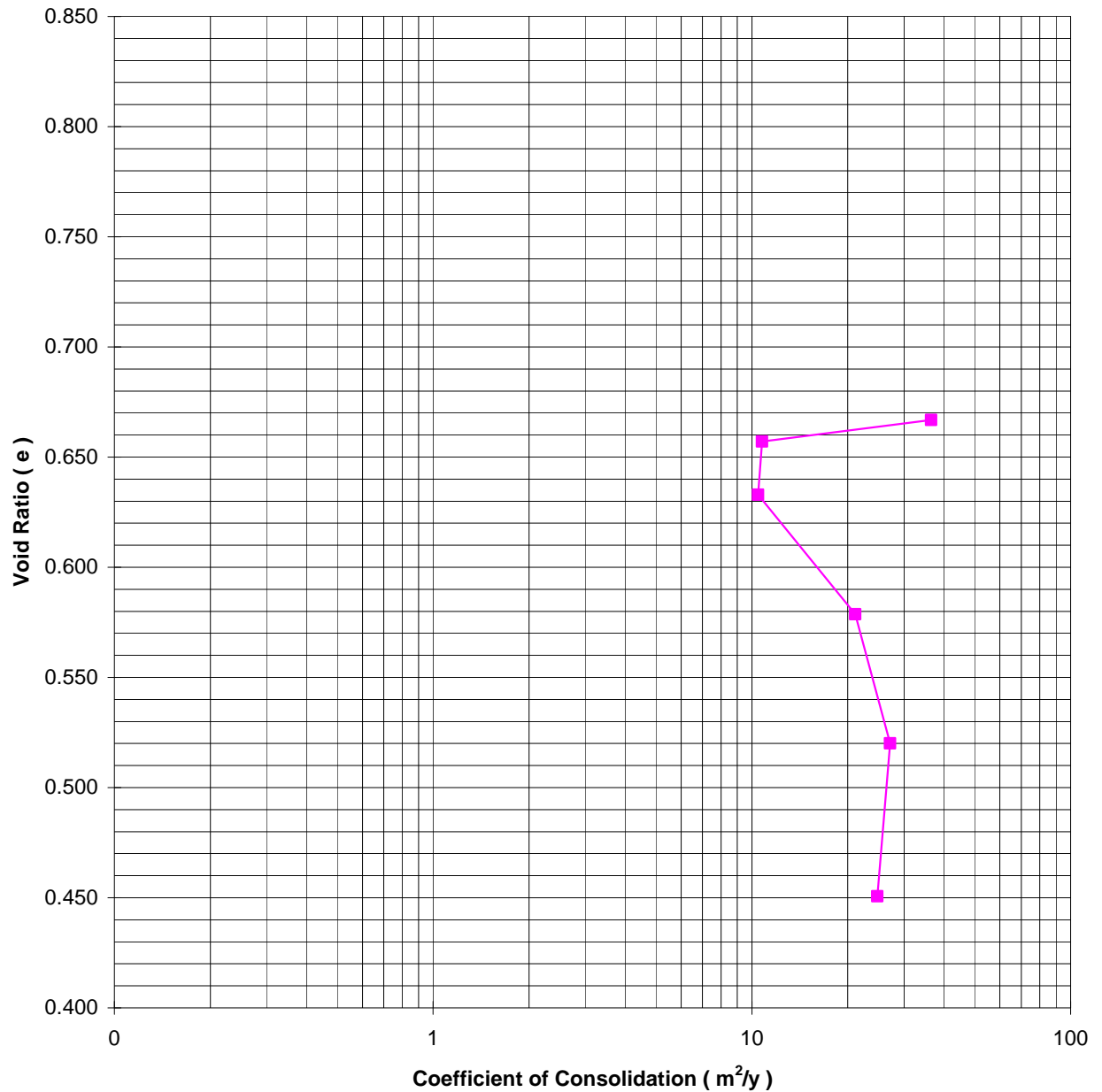


AMEC EARTH & ENVIRONMENTAL LIMITED

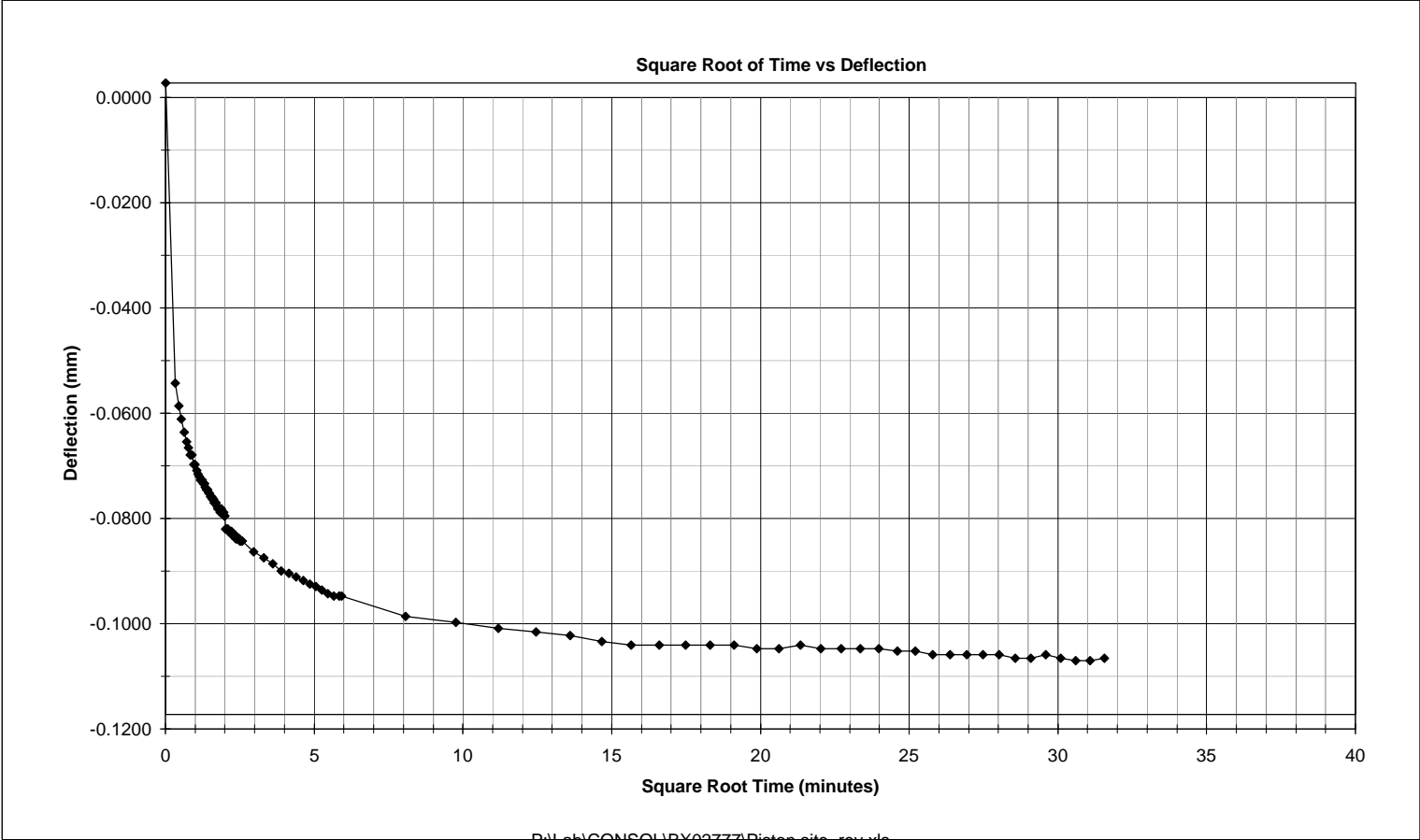
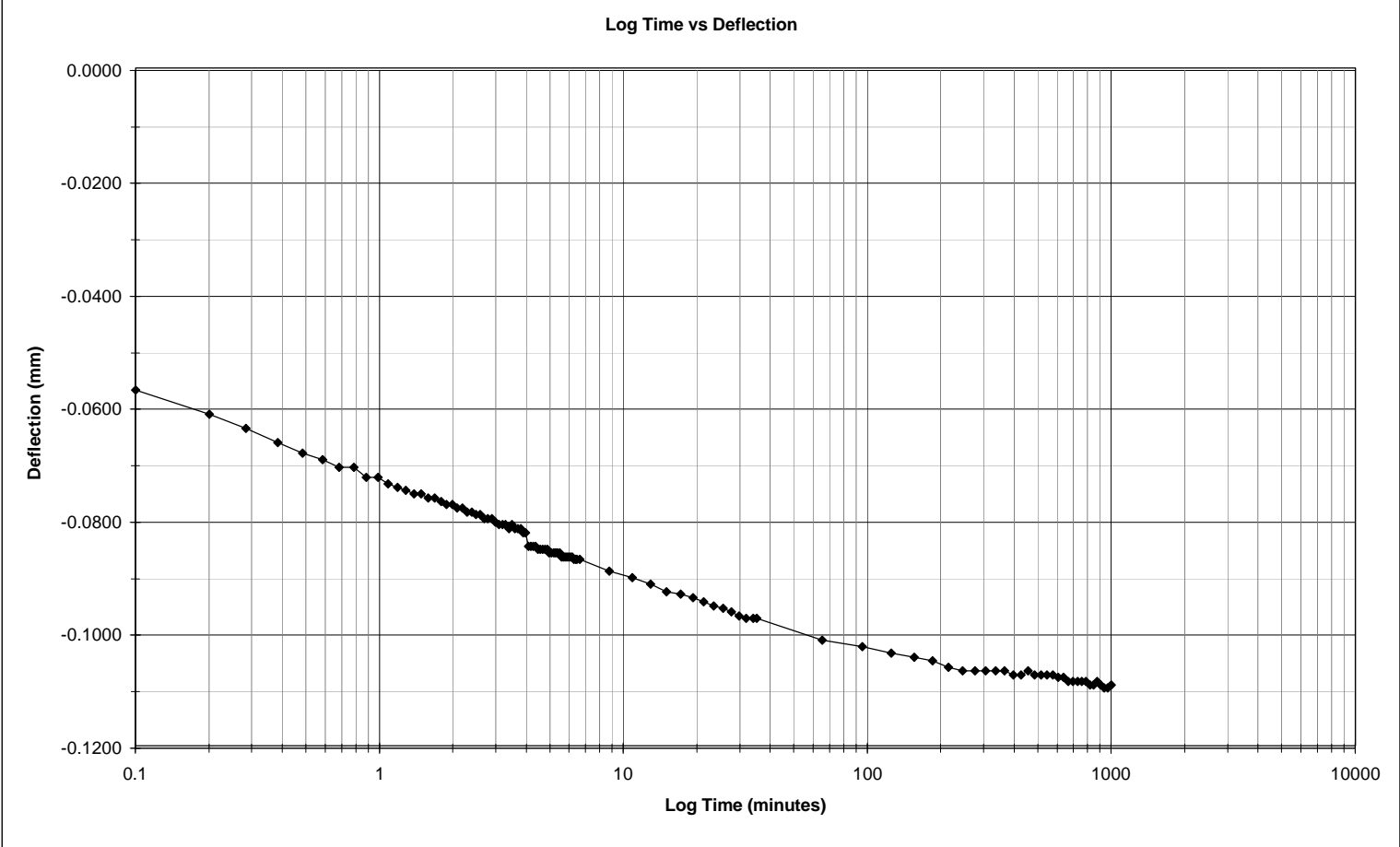
Engineering & Environmental Services
Edmonton, Alberta, Canada

ONE-DIMENSIONAL CONSOLIDATION TEST
(ASTM D2435-90)

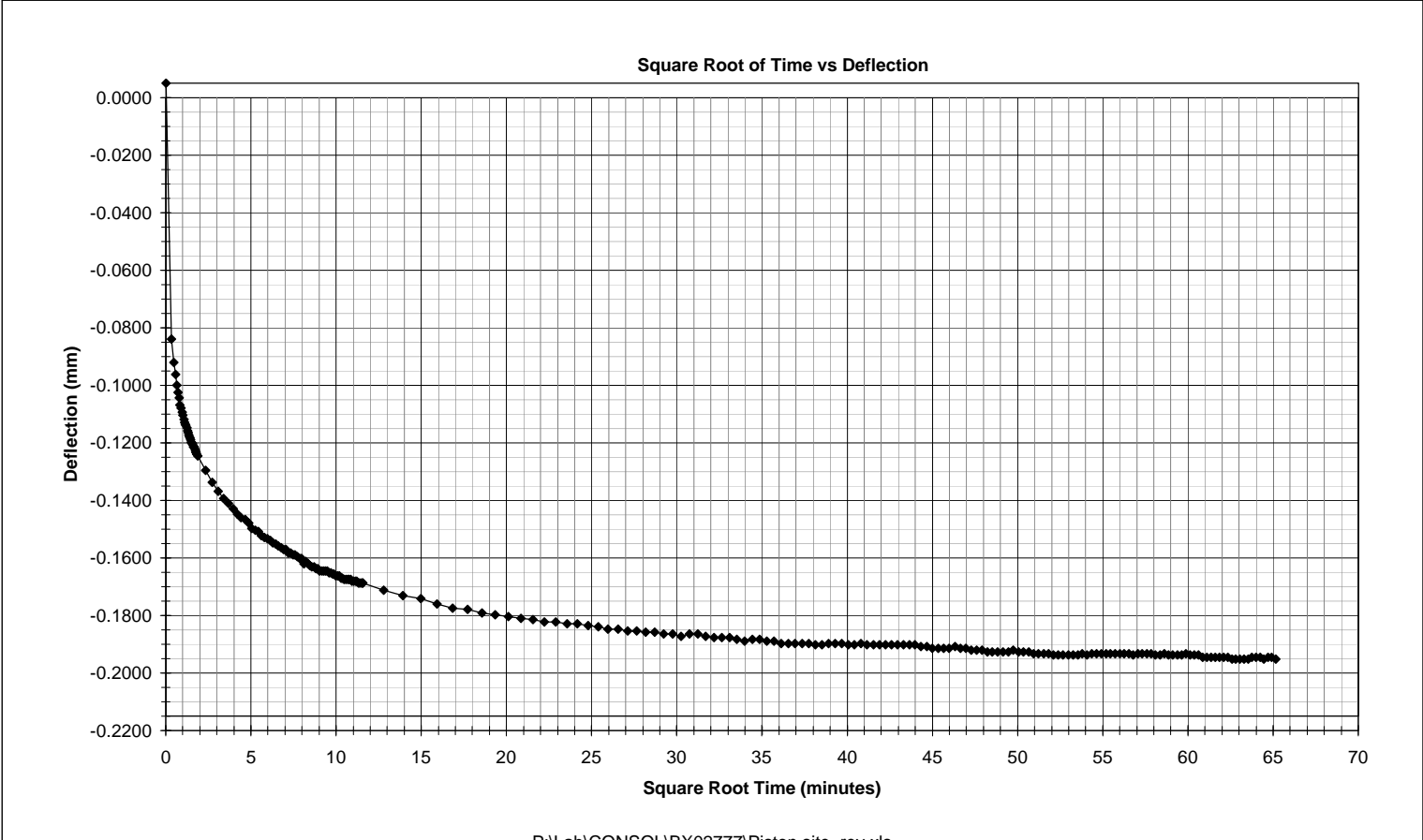
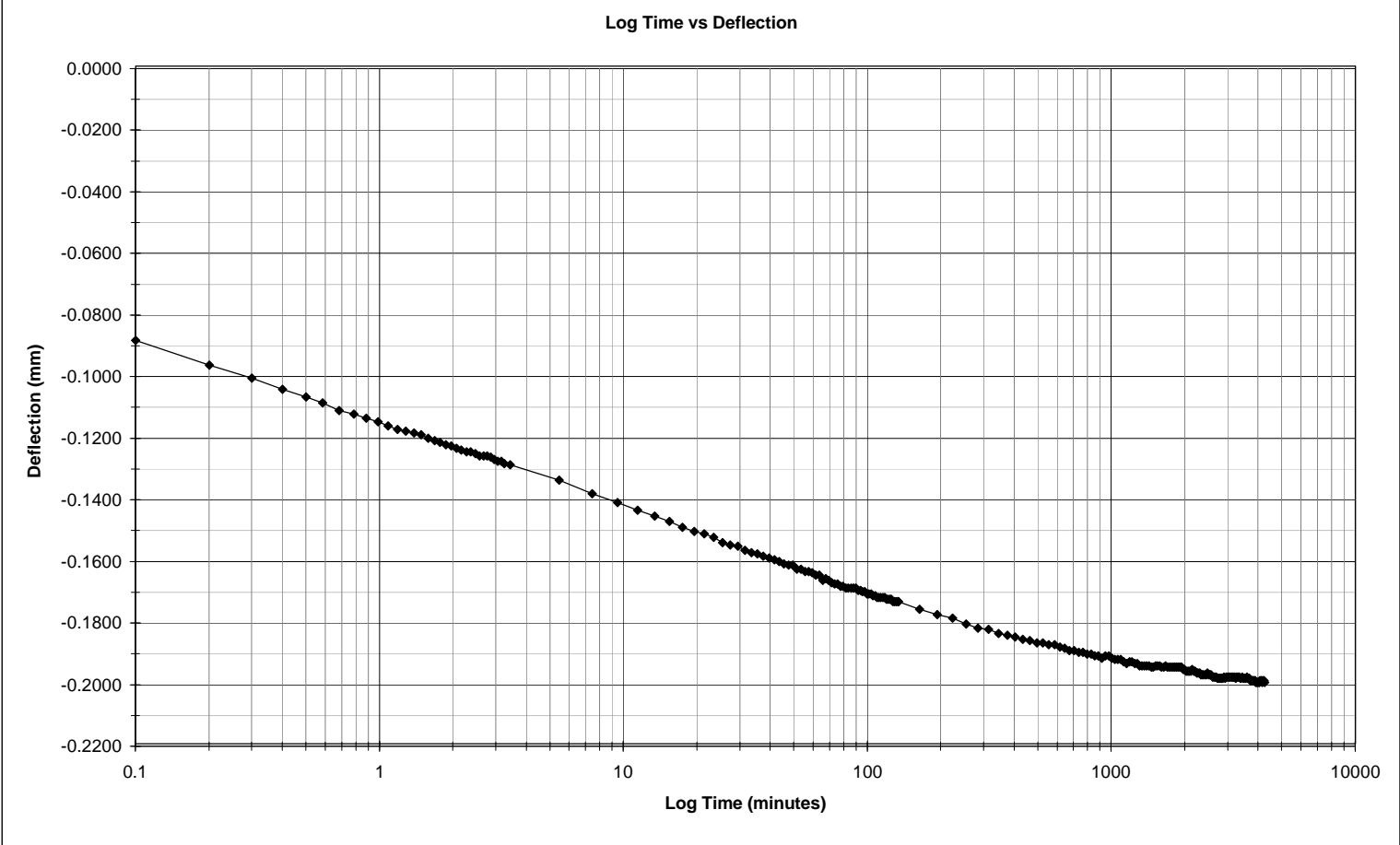
Project	Defence Research Development Canada		
Test	Test Method B (Remolded & Compacted Sample)		
Location	Medicine Hat		
Job No.	BX02777	Sample No.	Machine # 1
Hole No.	Piston Site	Depth (m)	-
Technician	LK	Date Started	06/11/2003

Void Ratio vs. Coefficient of Consolidation

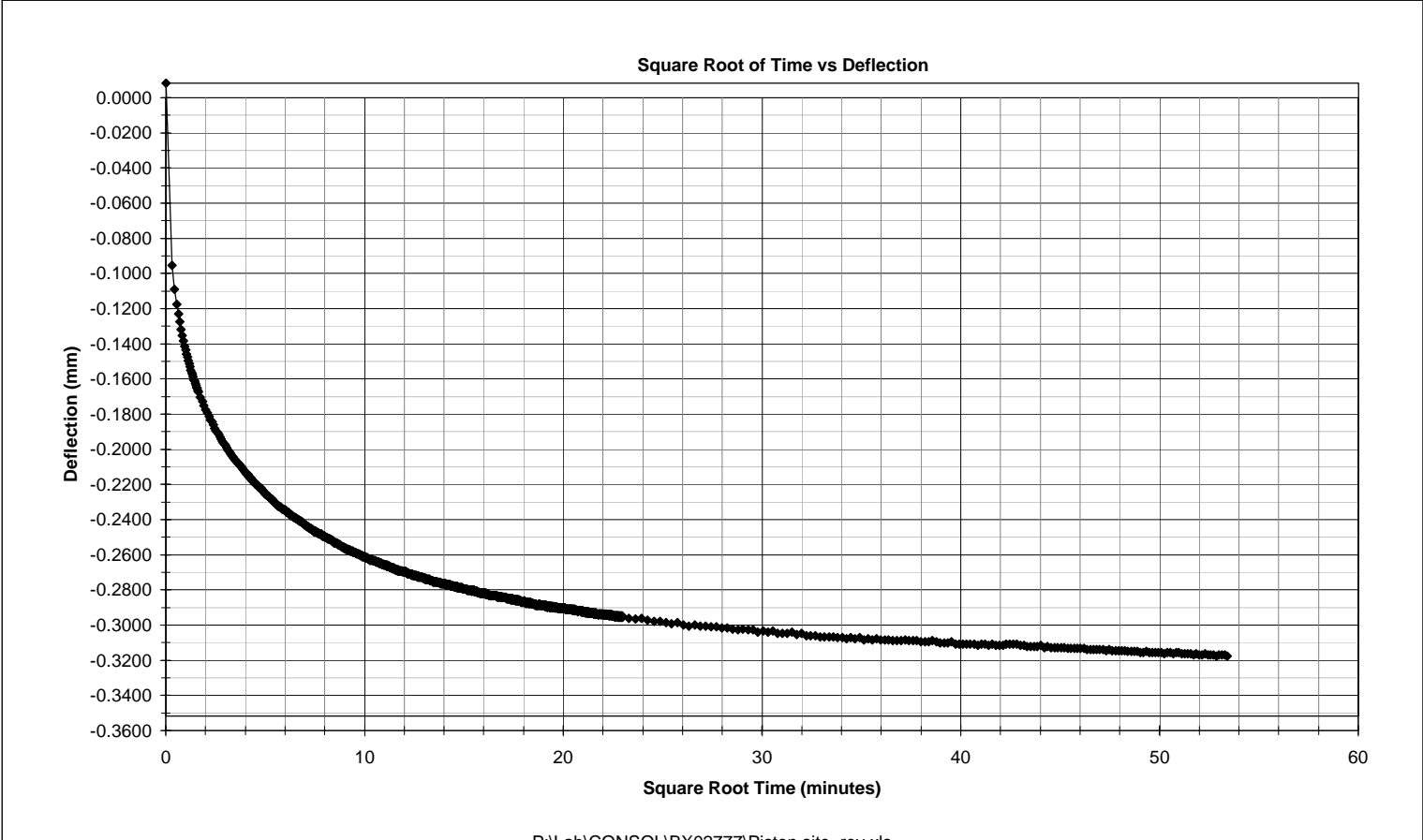
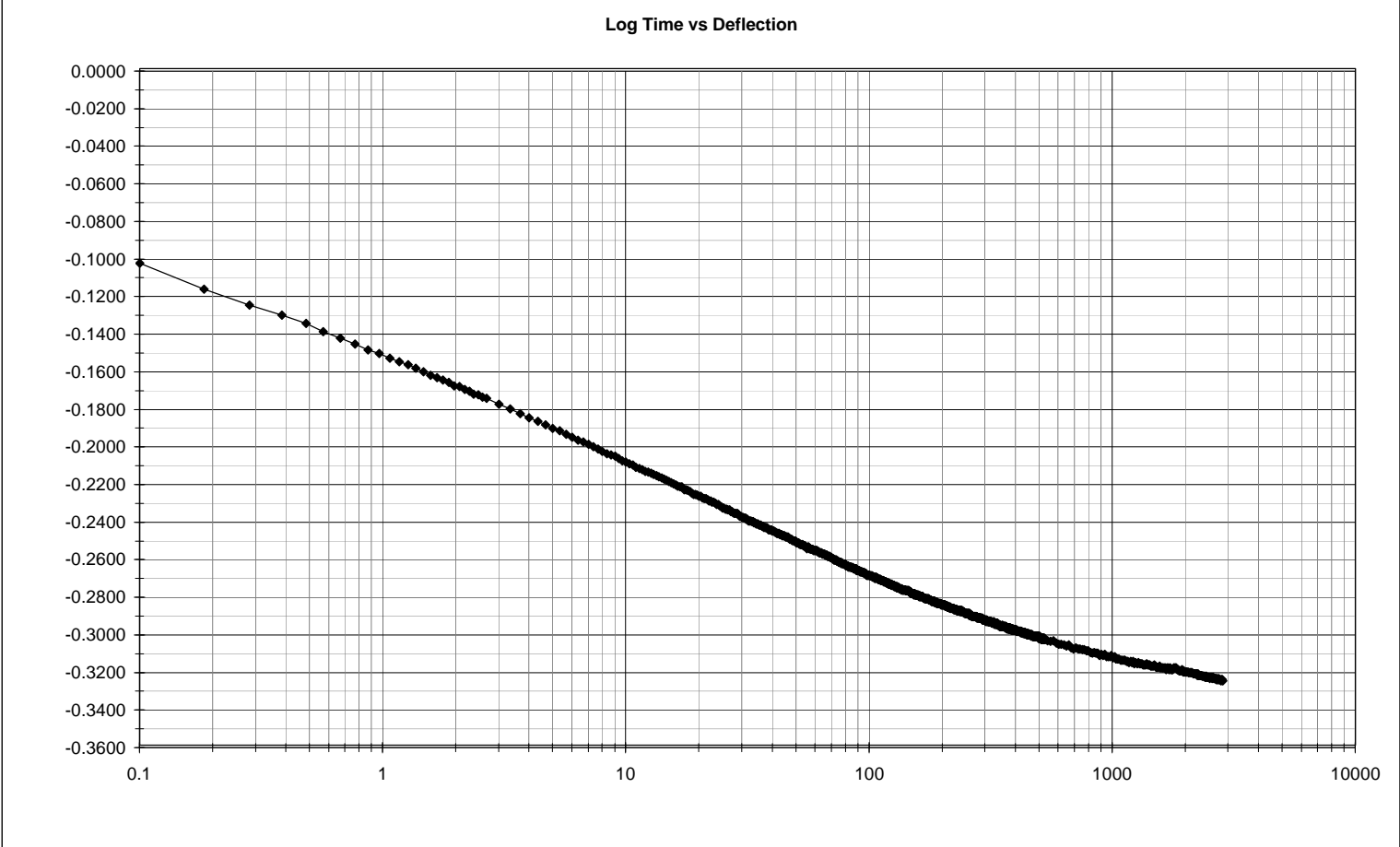
AMEC EARTH & ENVIRONMENTAL LIMITED <i>Engineering & Environmental Services</i> ONE-DIMENSIONAL CONSOLIDATION TEST (ASTM D2435-90)	Project	Defence Research Development Canada		
	Location	Medicine Hat		
	Job No.	BX02777	Sample No.	Machine # 1
	Hole No.	Piston Site	Depth (m)	-
	Technician	LK	Loading Date	06/11/2003
	Loading Stage	95.86kPa	Start Loading Time	17:10:19



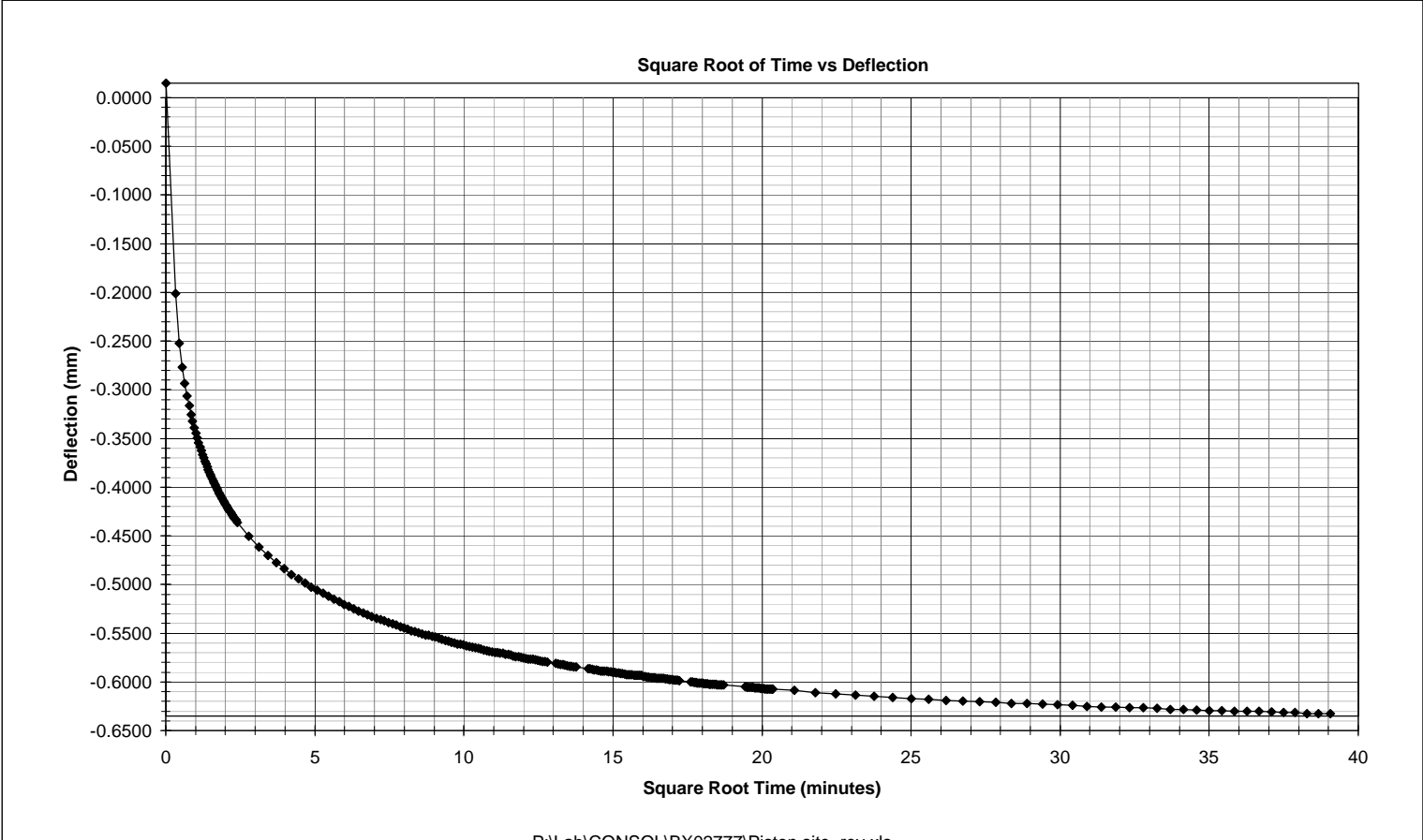
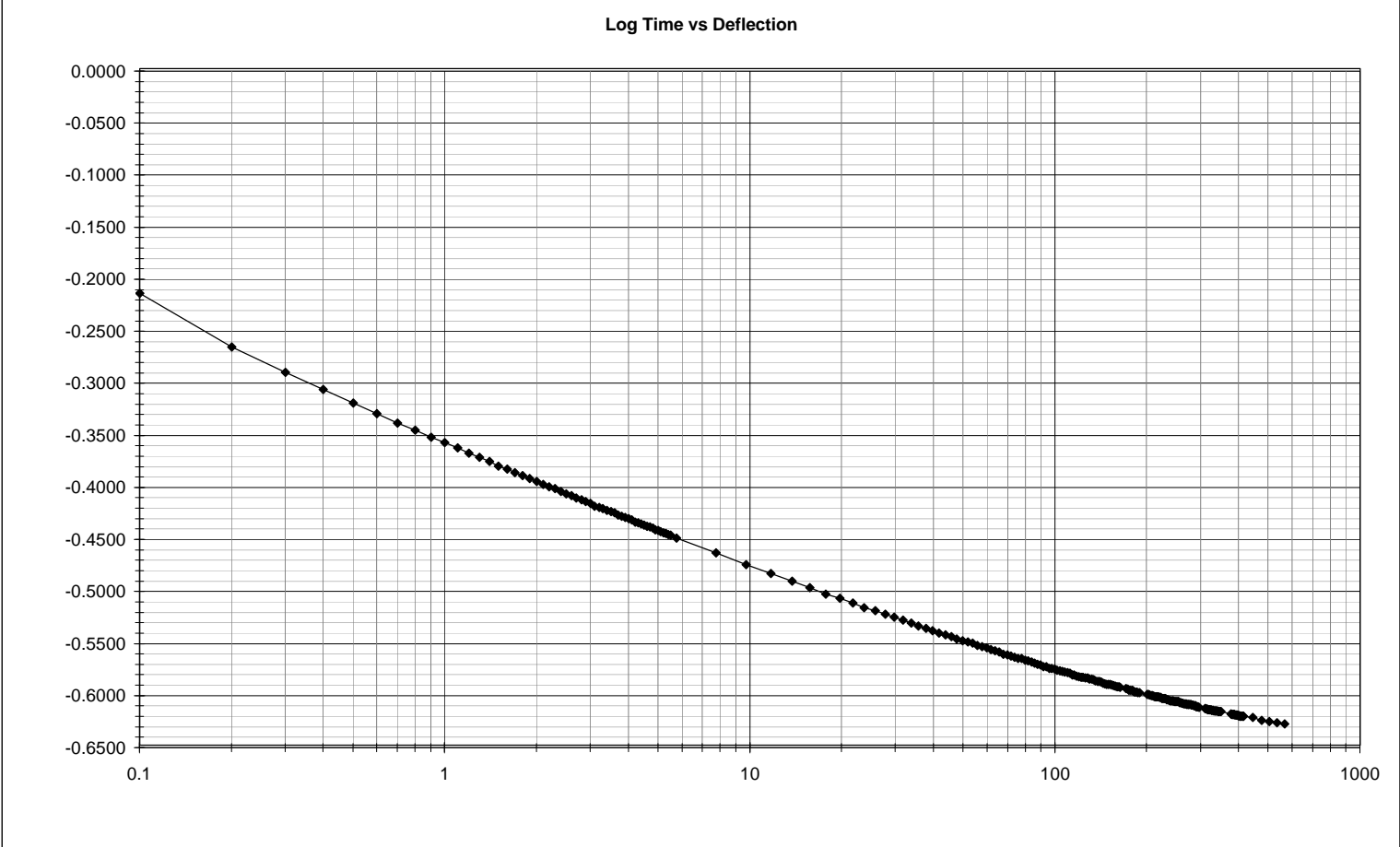
AMEC EARTH & ENVIRONMENTAL LIMITED <i>Engineering & Environmental Services</i> ONE-DIMENSIONAL CONSOLIDATION TEST (ASTM D2435-90)	Project	Defence Research Development Canada		
	Location	Medicine Hat		
	Job No.	BX02777	Sample No.	Machine # 1
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	Loading Stage	196.4 kPa	Start Loading Time	10:01:19



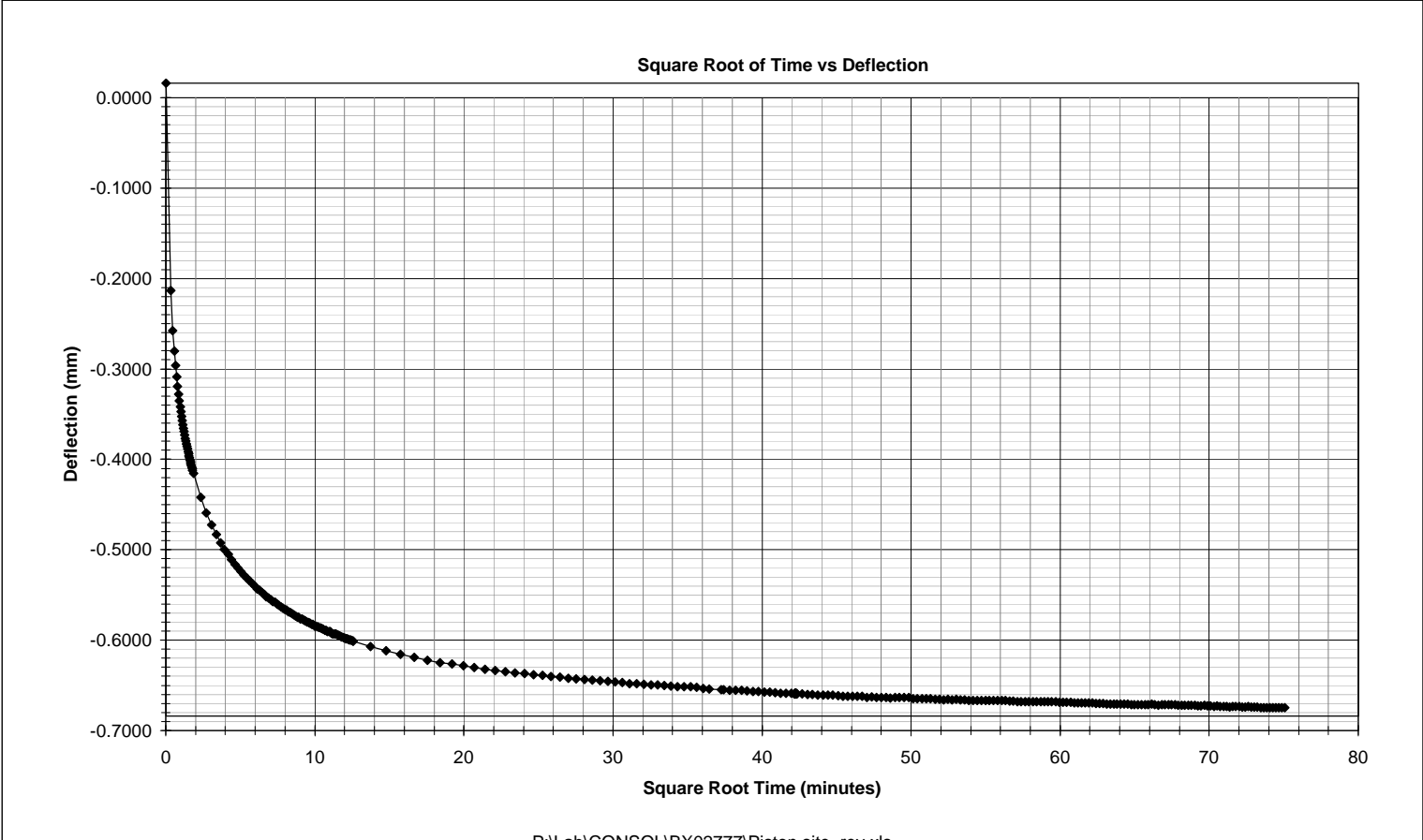
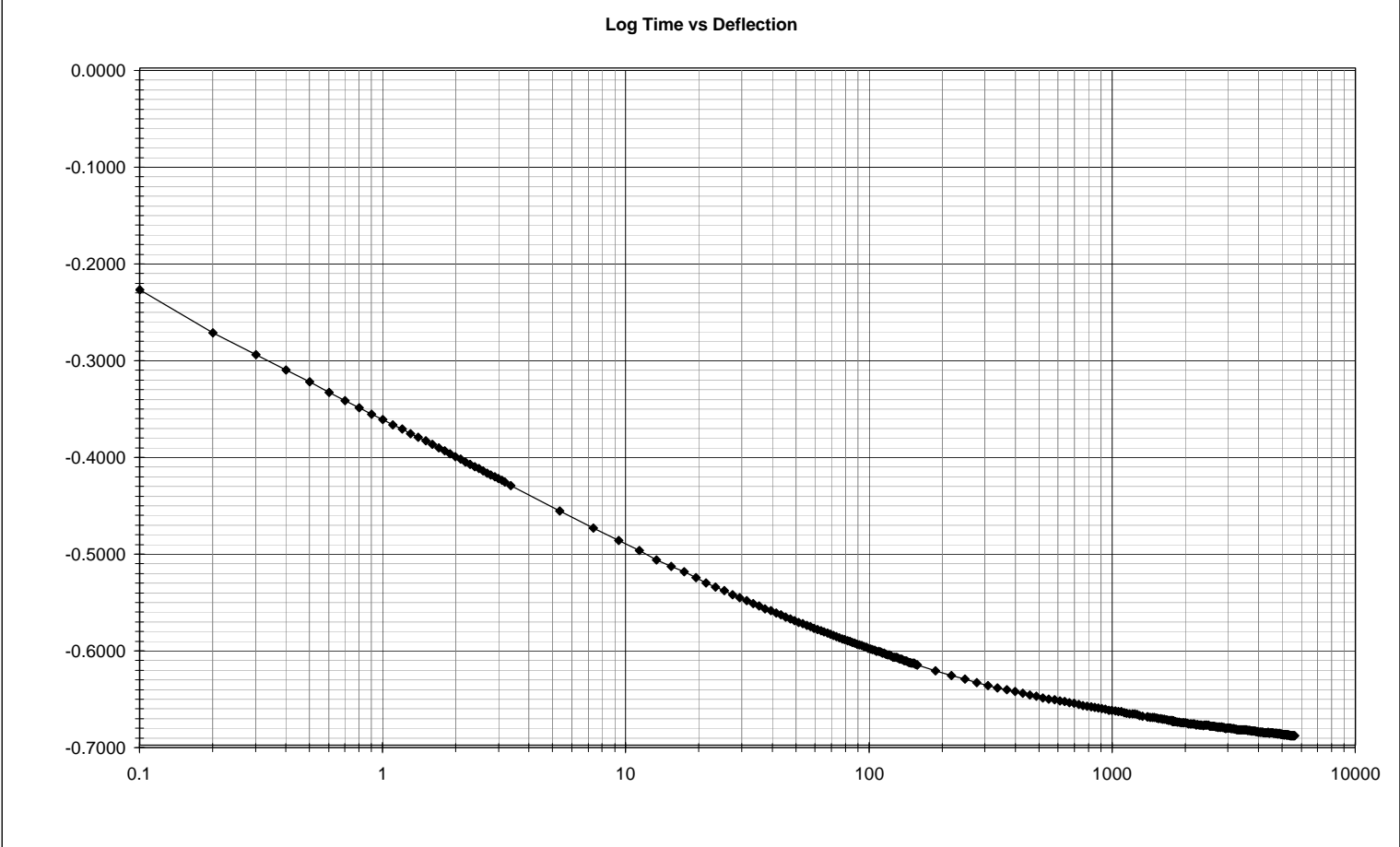
AMEC EARTH & ENVIRONMENTAL LIMITED <i>Engineering & Environmental Services</i> ONE-DIMENSIONAL CONSOLIDATION TEST (ASTM D2435-90)	Project	Defence Research Development Canada		
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	Job No.	BX02777	Sample No.	Machine # 1
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	Loading Stage	382.8 kPa	Start Loading Time	9:40:57



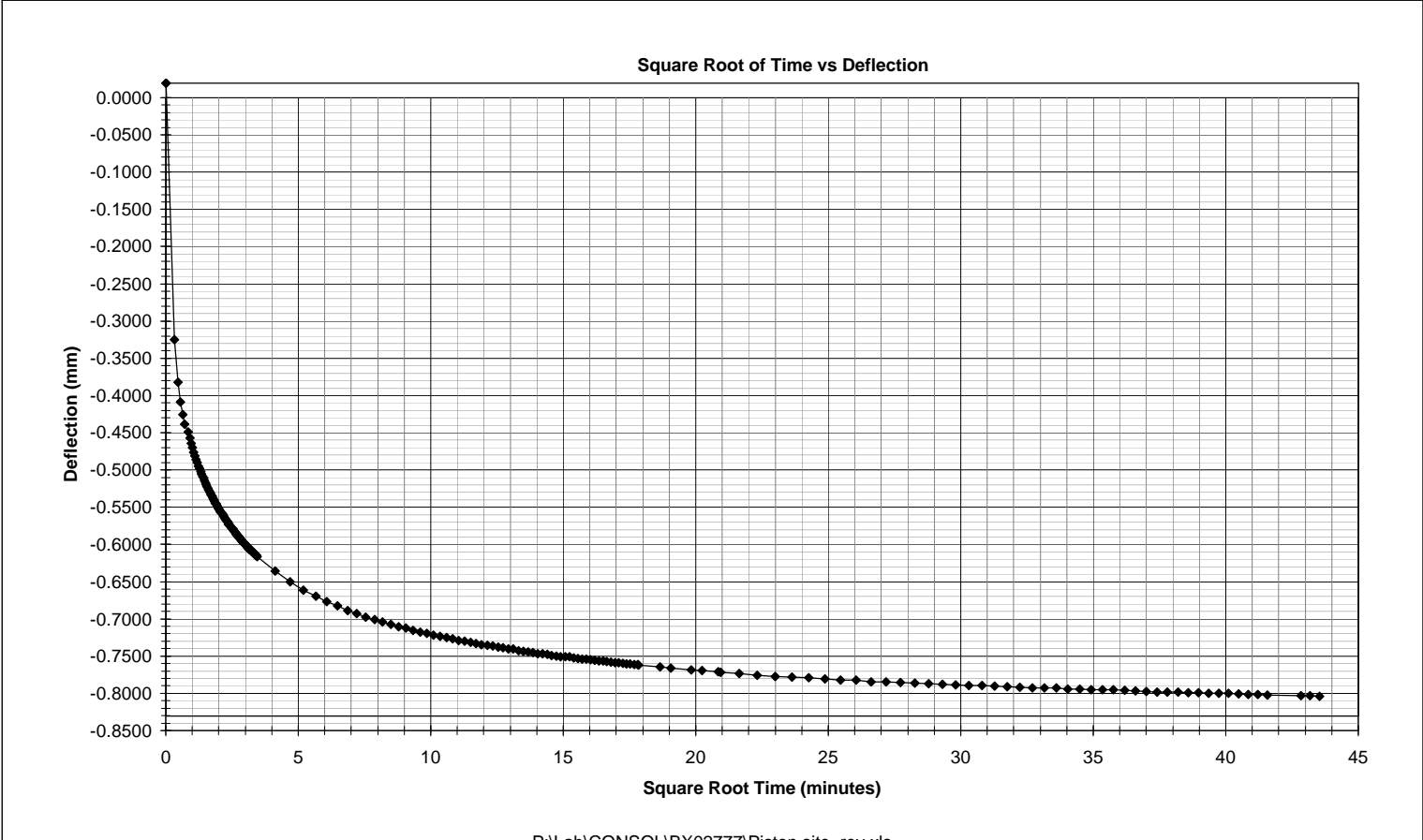
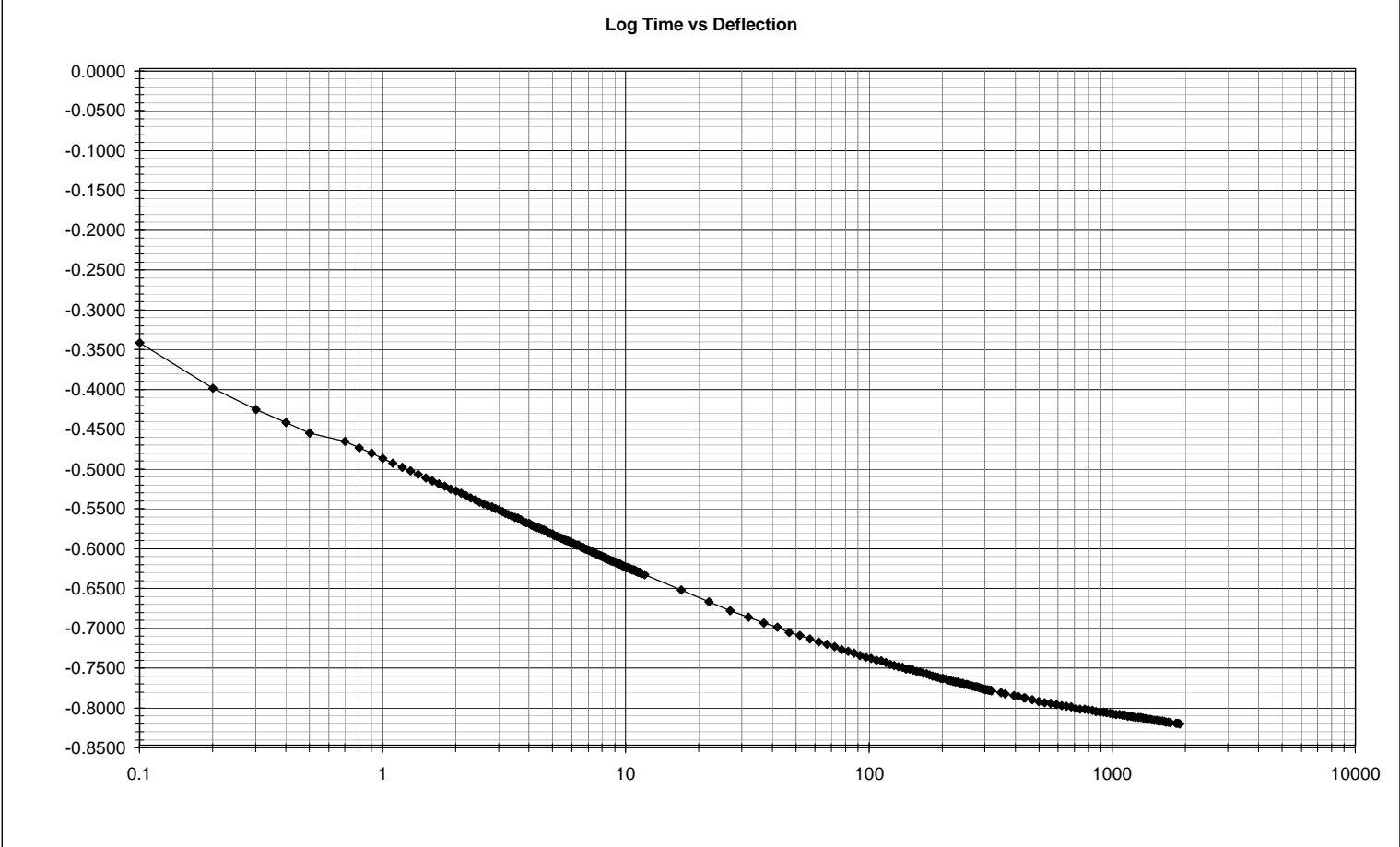
AMEC EARTH & ENVIRONMENTAL LIMITED <i>Engineering & Environmental Services</i> ONE-DIMENSIONAL CONSOLIDATION TEST (ASTM D2435-90)	Project	Defence Research Development Canada		
	Location	Medicine Hat		
	Job No.	BX02777	Sample No.	Machine # 1
	Hole No.	Piston Site	Depth (m)	-
	Technician	LK	Loading Date	12/11/2003
	Loading Stage	757.68 kPa	Start Loading Time	9:40:34



AMEC EARTH & ENVIRONMENTAL LIMITED <i>Engineering & Environmental Services</i> ONE-DIMENSIONAL CONSOLIDATION TEST (ASTM D2435-90)	Project	Defence Research Development Canada		
	Location	Medicine Hat		
	Job No.	BX02777	Sample No.	Machine # 1
	Hole No.	Piston Site	Depth (m)	-
	Technician	LK	Loading Date	13/11/2003
	Loading Stage	1513.9 kPa	Start Loading Time	11:54:21



AMEC EARTH & ENVIRONMENTAL LIMITED <i>Engineering & Environmental Services</i> ONE-DIMENSIONAL CONSOLIDATION TEST (ASTM D2435-90)	Project	Defence Research Development Canada		
	Location	Medicine Hat		
	Job No.	BX02777	Sample No.	Machine # 1
	Hole No.	Piston Site	Depth (m)	-
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	Loading Stage	3012.2 kPa	Start Loading Time	10:24:03



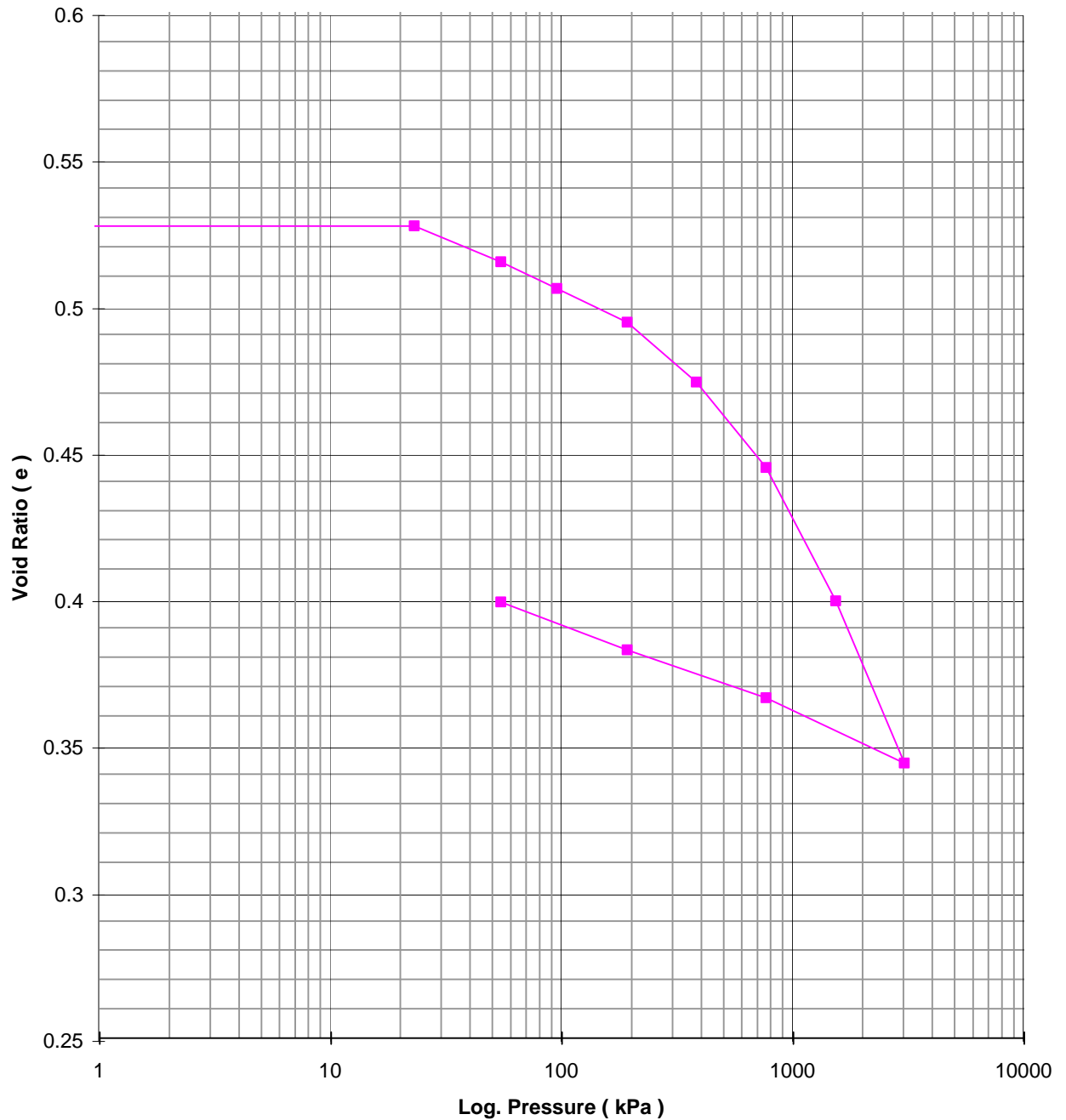
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	Test	Test Method B (Remolded & Compacted Sample)		
	Location	Medicine Hat, AB		
	Job No.	BX02777	Sample No.	Machine # 7
	Hole No.	Onager Site	Depth (m)	-
	Technician	LK	Date Started	05/11/2003

Specimen Data	Initial	Final		Index Tests		Calculated	Final
Specimen Height	19.990	18.311	mm	Specific Gravity (Assumed)		2.69	
Volume of Specimen	68.63	62.87	ml				
Volume of Solids	44.94	44.94	ml				
Volume of Voids	23.69	17.92	ml				
Volume of Water	16.40	18.10	ml				
Void Ratio	0.527	0.399					
Saturation	69	101	%				
Moisture Content	13.6	15.0	%	Soil Description	Clay, low plastic, sandy, silty, brown, roots.		
Height of Solids	13.09	13.09	mm				

[illegible]

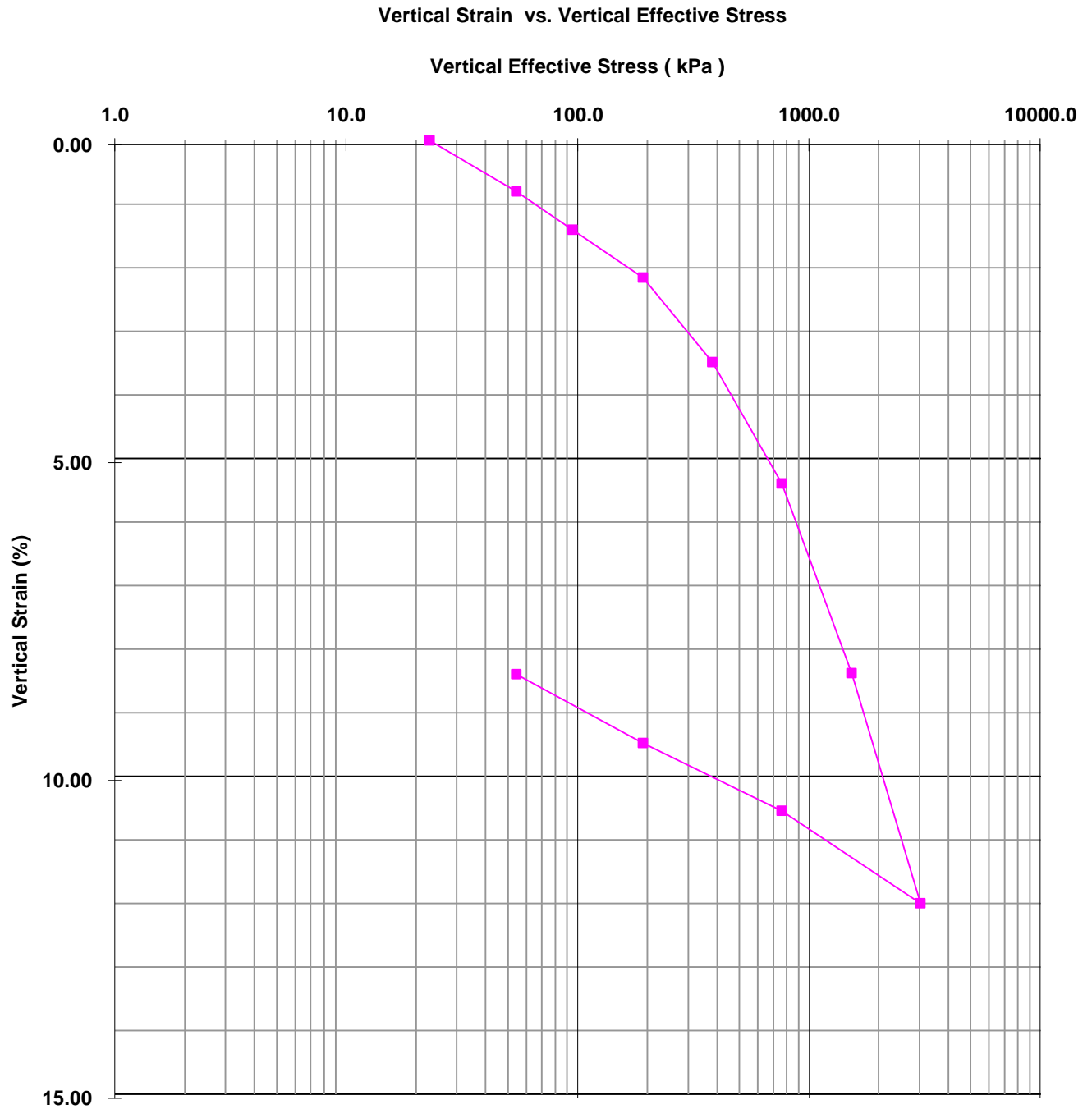
AMEC EARTH & ENVIRONMENTAL LIMITED*Engineering & Environmental Services
Edmonton, Alberta, Canada***ONE-DIMENSIONAL CONSOLIDATION TEST**
(ASTM D2435-90)

Project	Defence Research Development Canada		
Test	Test Method B (Remolded & Compacted Sample)		
Location	Medicine Hat, AB		
Job No.	BX02777	Sample No.	Machine # 7
Hole No.	Onager Site	Depth (m)	-
Technician	LK	Date Started	05/11/2003

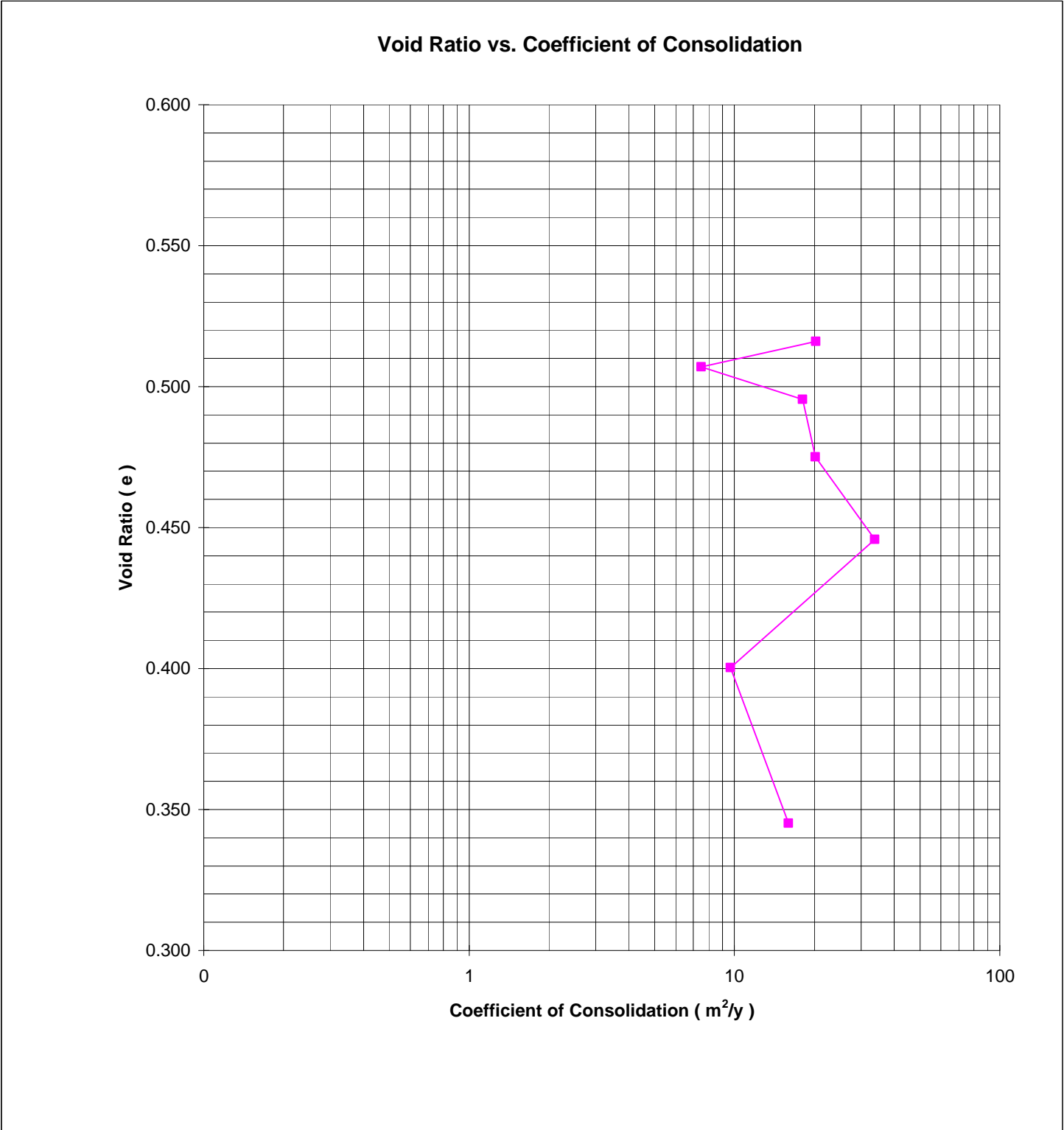
Void ratio vs. Log Pressure

AMEC EARTH & ENVIRONMENTAL LIMITED*Engineering & Environmental Services
Edmonton, Alberta, Canada***ONE-DIMENSIONAL CONSOLIDATION TEST**
(ASTM D2435-90)

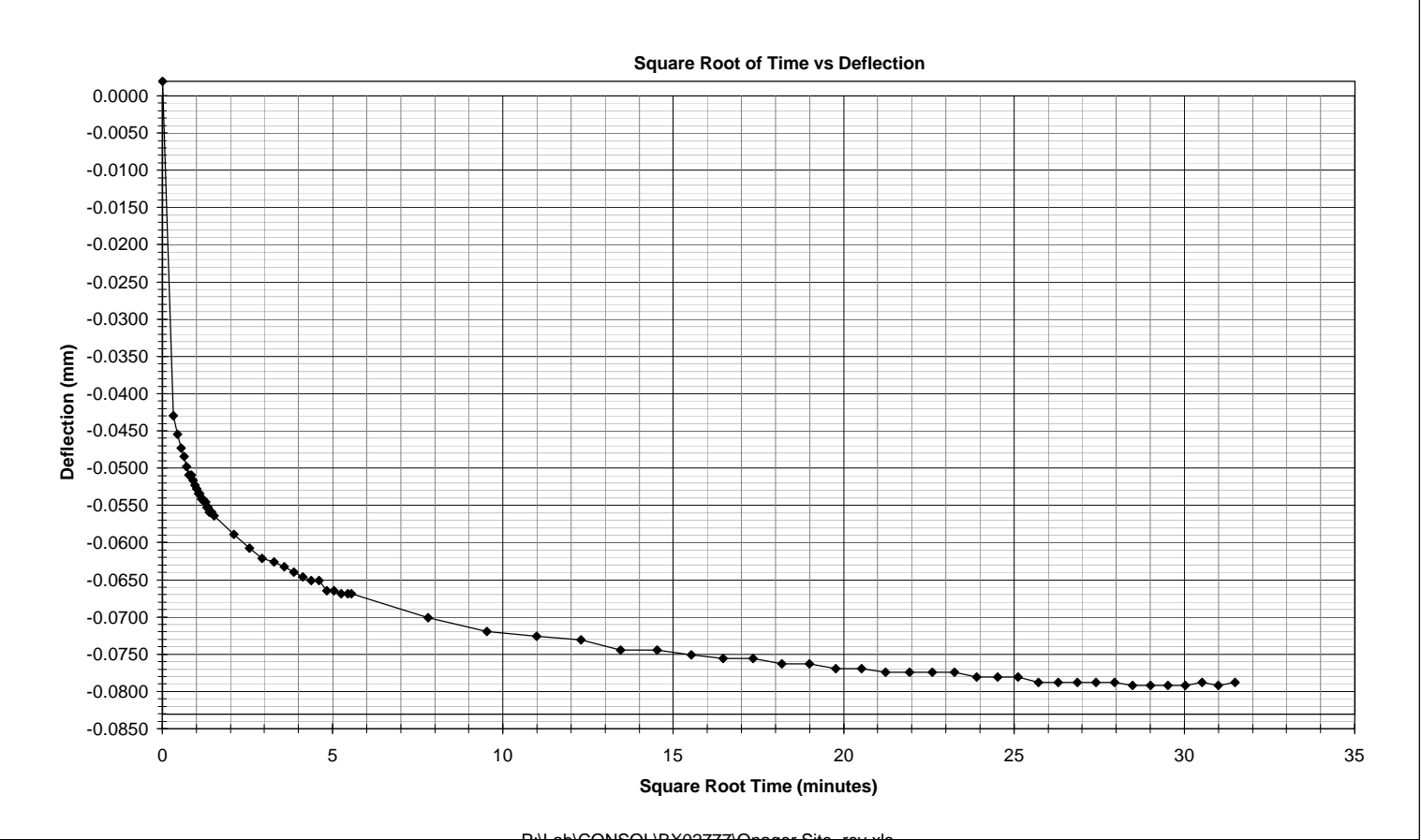
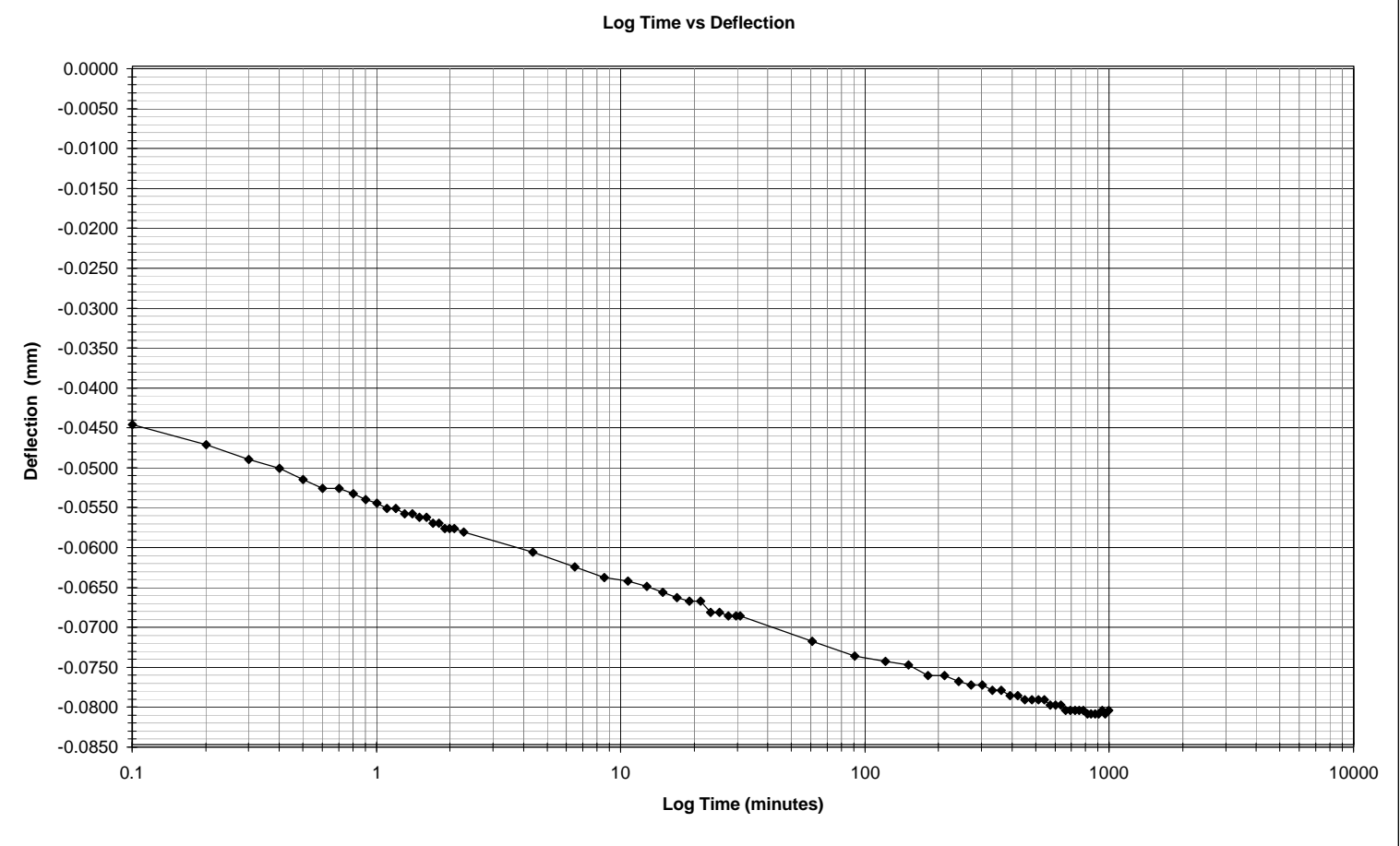
Project	Defence Research Development Canada		
Test	Test Method B (Remolded & Compacted Sample)		
Location	Medicine Hat, AB		
Job No.	BX02777	Sample No.	Machine # 7
Hole No.	Onager Site	Depth (m)	-
Technician	LK	Date Started	05/11/2003



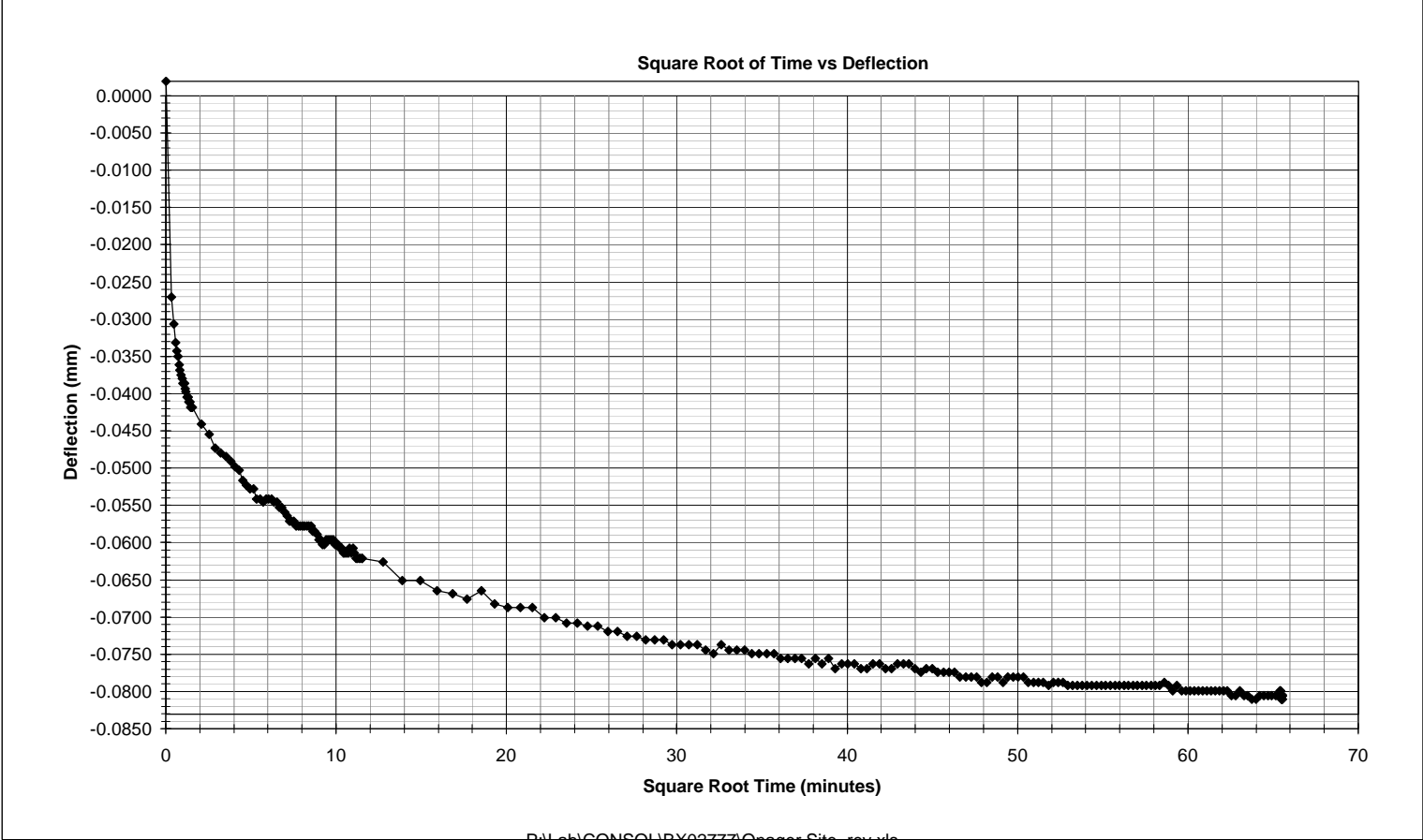
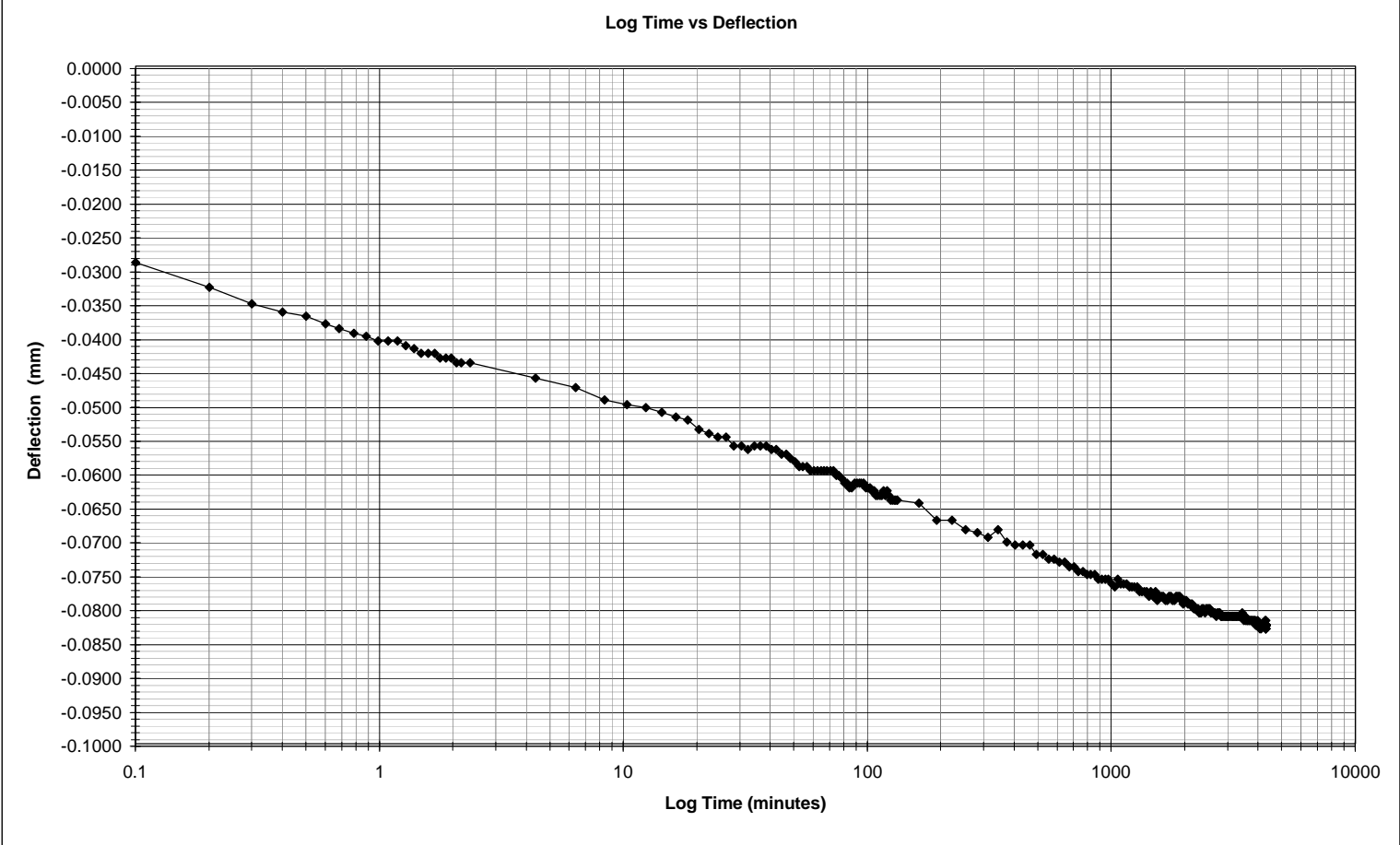
AMEC EARTH & ENVIRONMENTAL LIMITED <i>Engineering & Environmental Services</i> <i>Edmonton, Alberta, Canada</i> ONE-DIMENSIONAL CONSOLIDATION TEST (ASTM D2435-90)	Project	Defence Research Development Canada		
	Test	Test Method B (Remolded & Compacted Sample)		
	Location	Medicine Hat, AB		
	Job No.	BX02777	Sample No.	Machine # 7
	Hole No.	Onager Site	Depth (m)	-
	Technician	LK	Date Started	05/11/2003



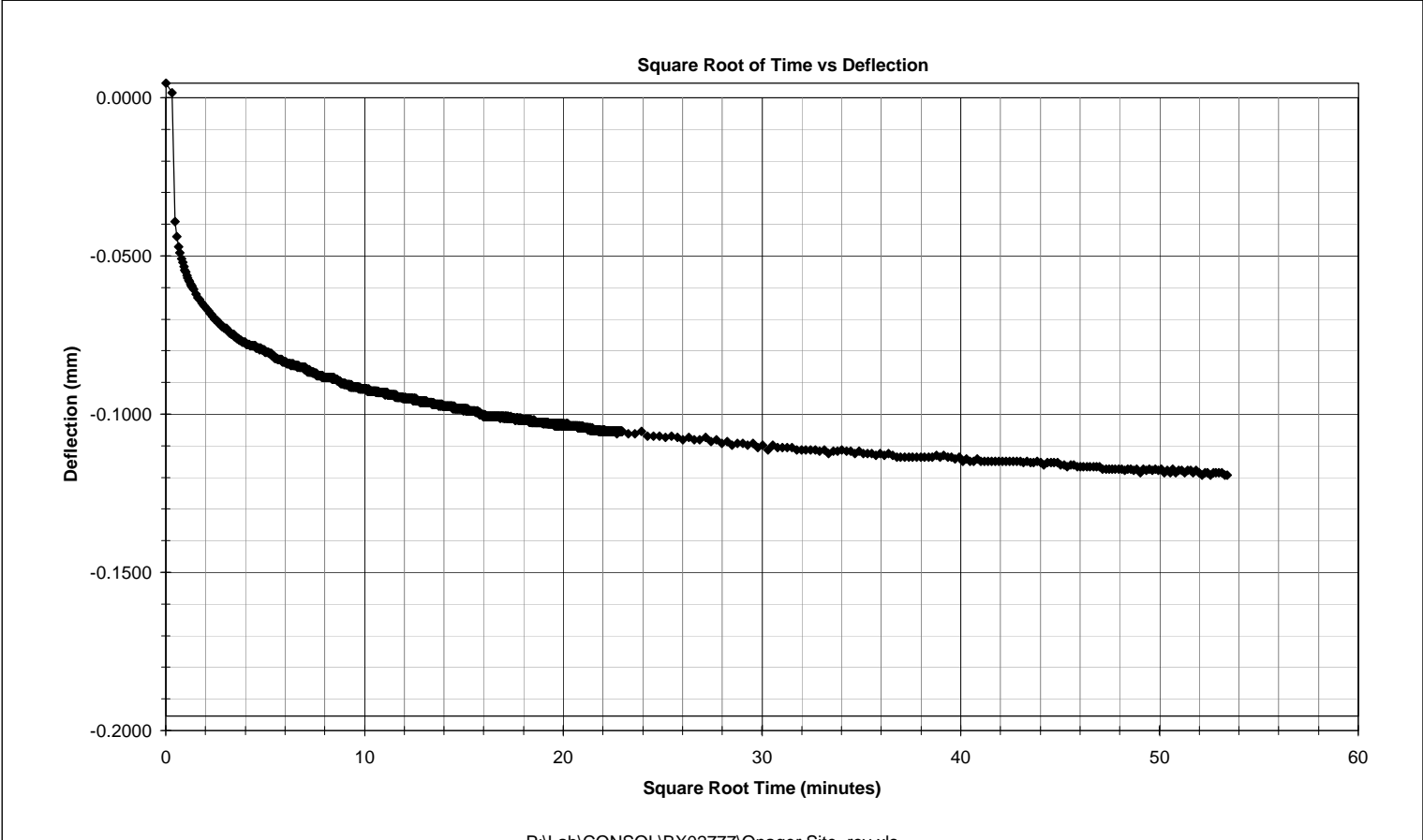
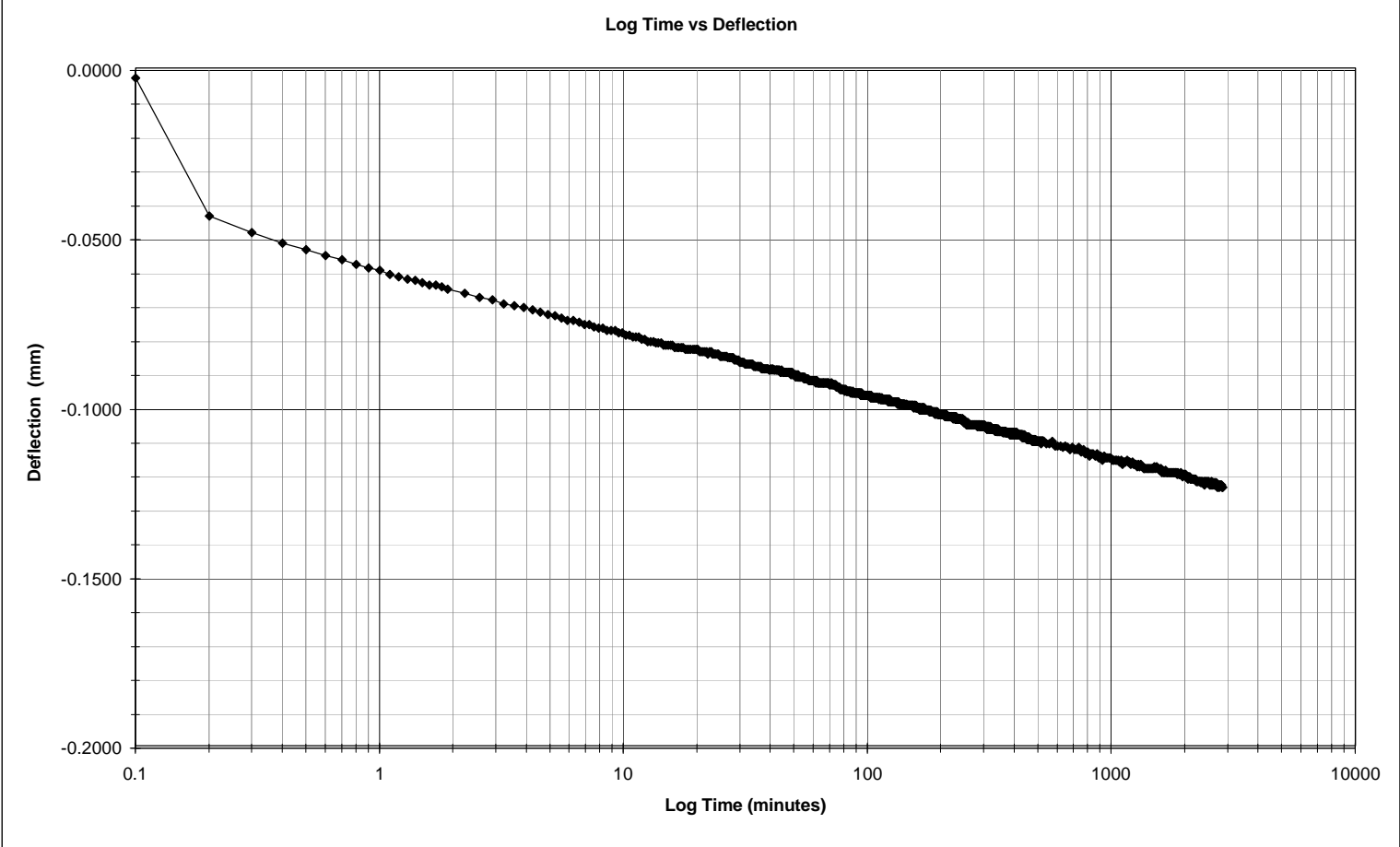
AMEC EARTH & ENVIRONMENTAL LIMITED <i>Engineering & Environmental Services</i> ONE-DIMENSIONAL CONSOLIDATION TEST (ASTM D2435-90)	Project	Defence Research Development Canada		
	Location	Medicine Hat, AB		
	Job No.	BX02777	Sample No.	Machine # 7
	Hole No.	Onager Site	Depth (m)	-
	Technician	LK	Loading Date	06/11/2003
	Loading Stage	54.45 kPa	Start Loading Time	17:14:41 PM



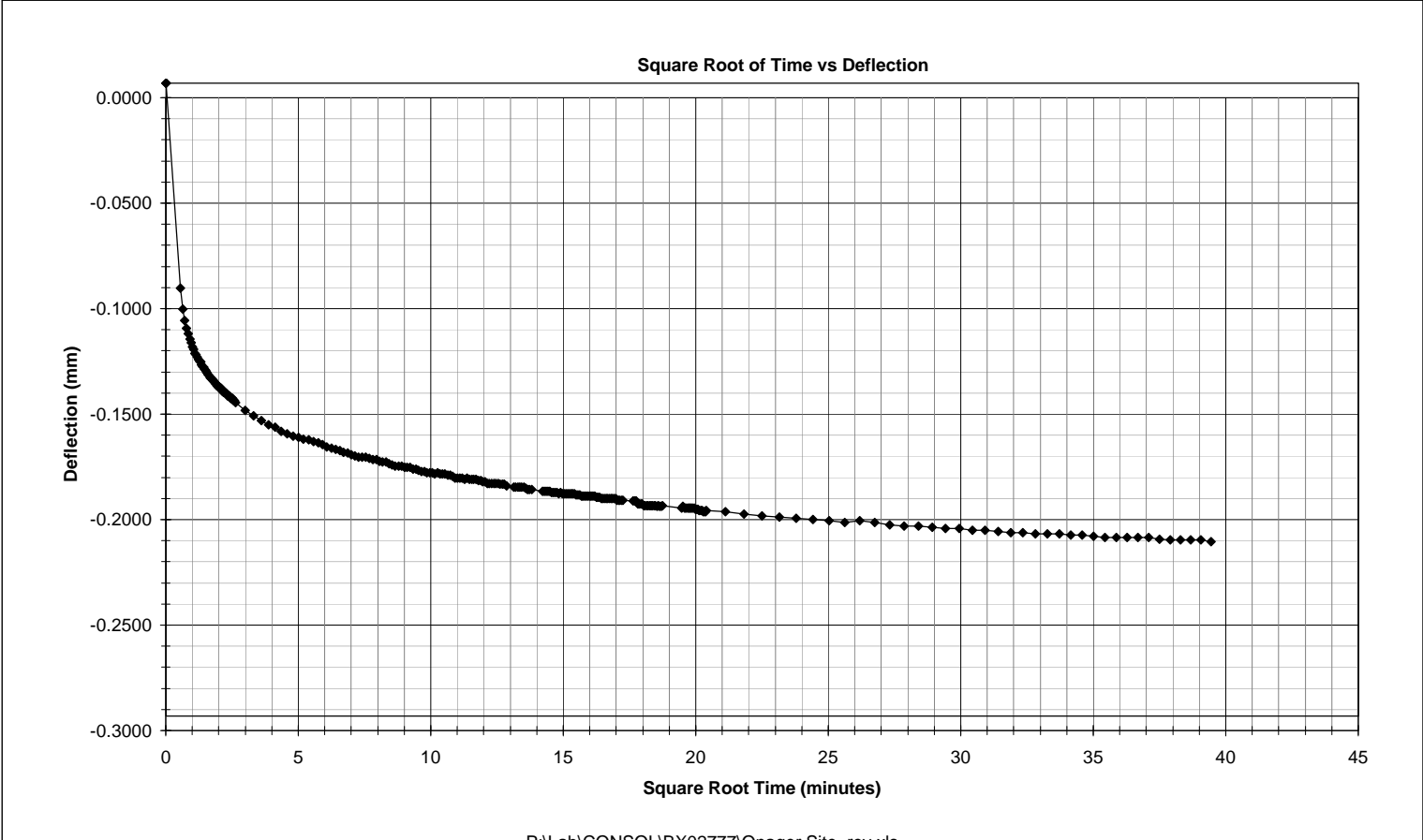
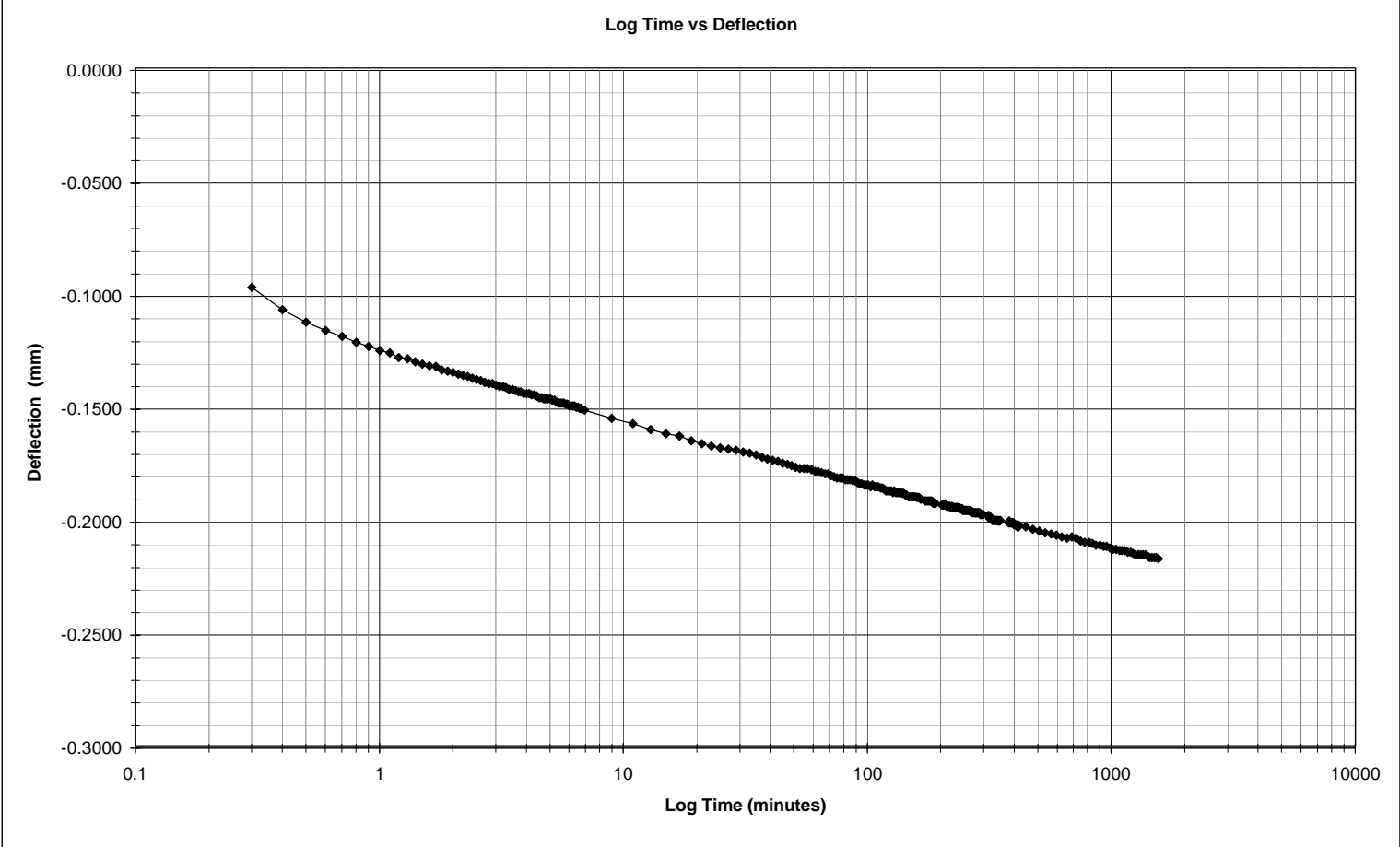
AMEC EARTH & ENVIRONMENTAL LIMITED <i>Engineering & Environmental Services</i> ONE-DIMENSIONAL CONSOLIDATION TEST (ASTM D2435-90)	Project	Defence Research Development Canada		
	Location	Medicine Hat, AB		
	Job No.	BX02777	Sample No.	Machine # 7
	Hole No.	Onager Site	Depth (m)	-
	Technician	LK	Loading Date	07/11/2003
	Loading Stage	95.23 kPa	Start Loading Time	10:02:24



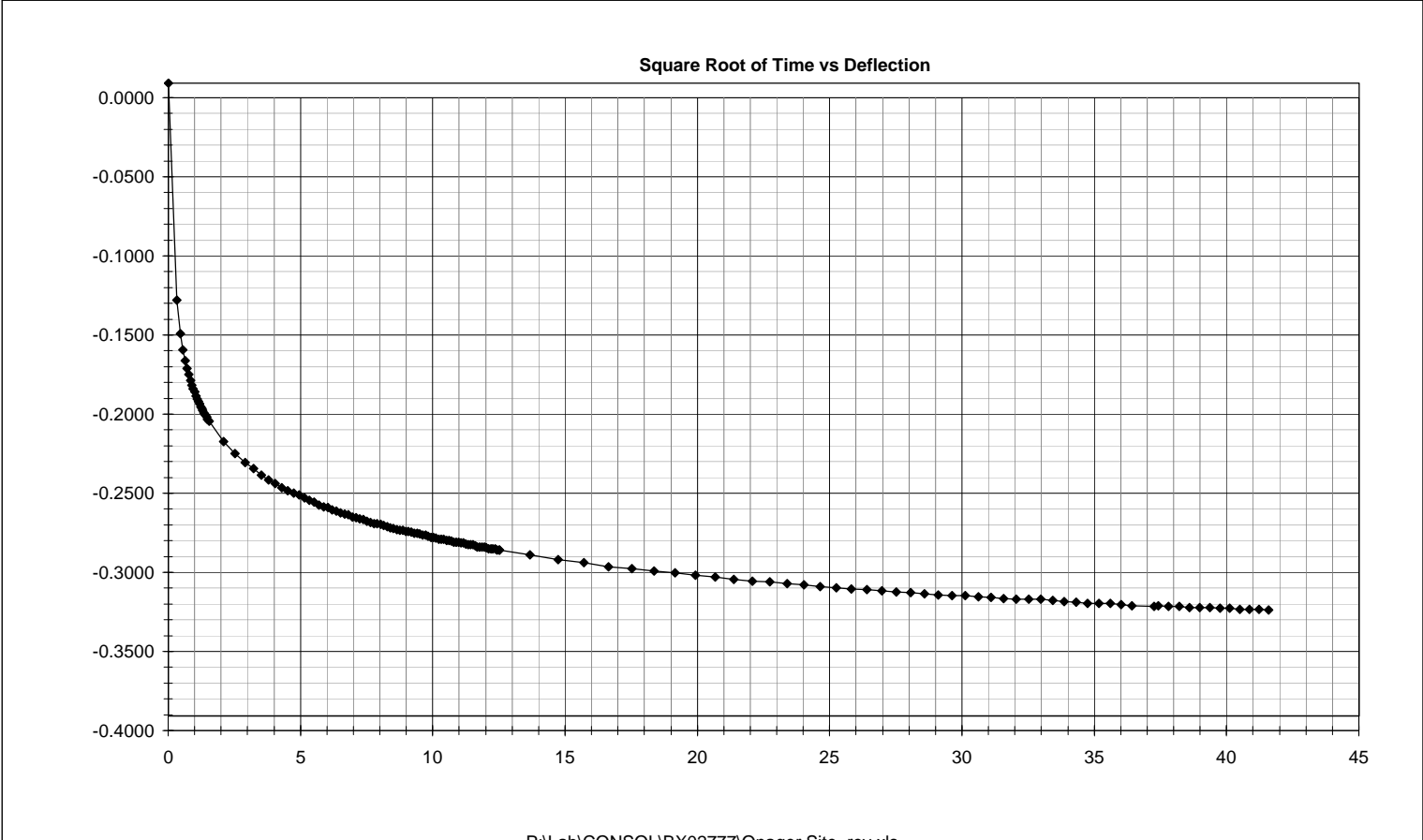
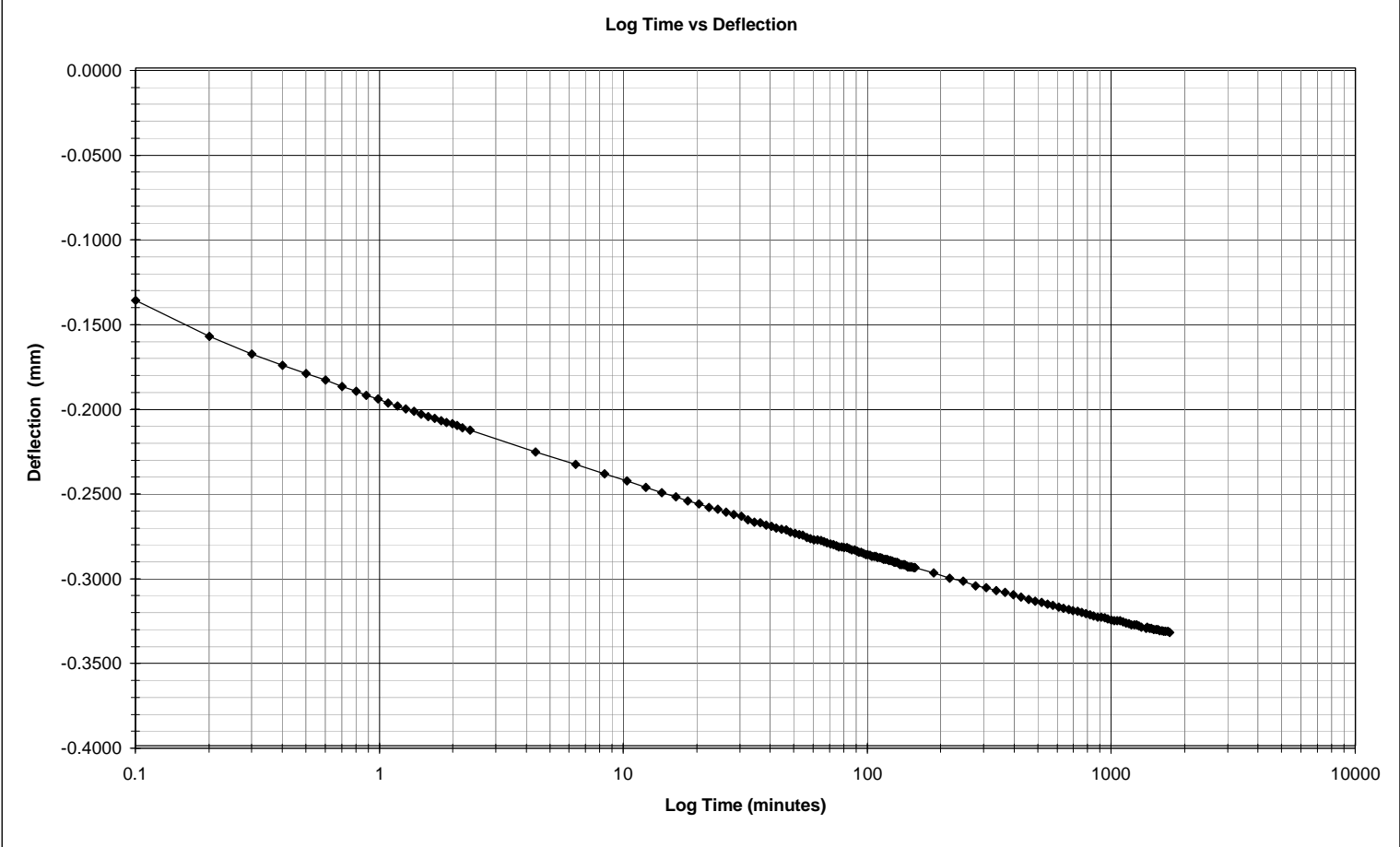
AMEC EARTH & ENVIRONMENTAL LIMITED <i>Engineering & Environmental Services</i> ONE-DIMENSIONAL CONSOLIDATION TEST (ASTM D2435-90)	Project	Defence Research Development Canada		
	Location	Medicine Hat, AB		
	Job No.	BX02777	Sample No.	Machine # 7
	Hole No.	Onager Site	Depth (m)	-
	Technician	LK	Loading Date	10/11/2003
	Loading Stage	191.85 kPa	Start Loading Time	9:41:43



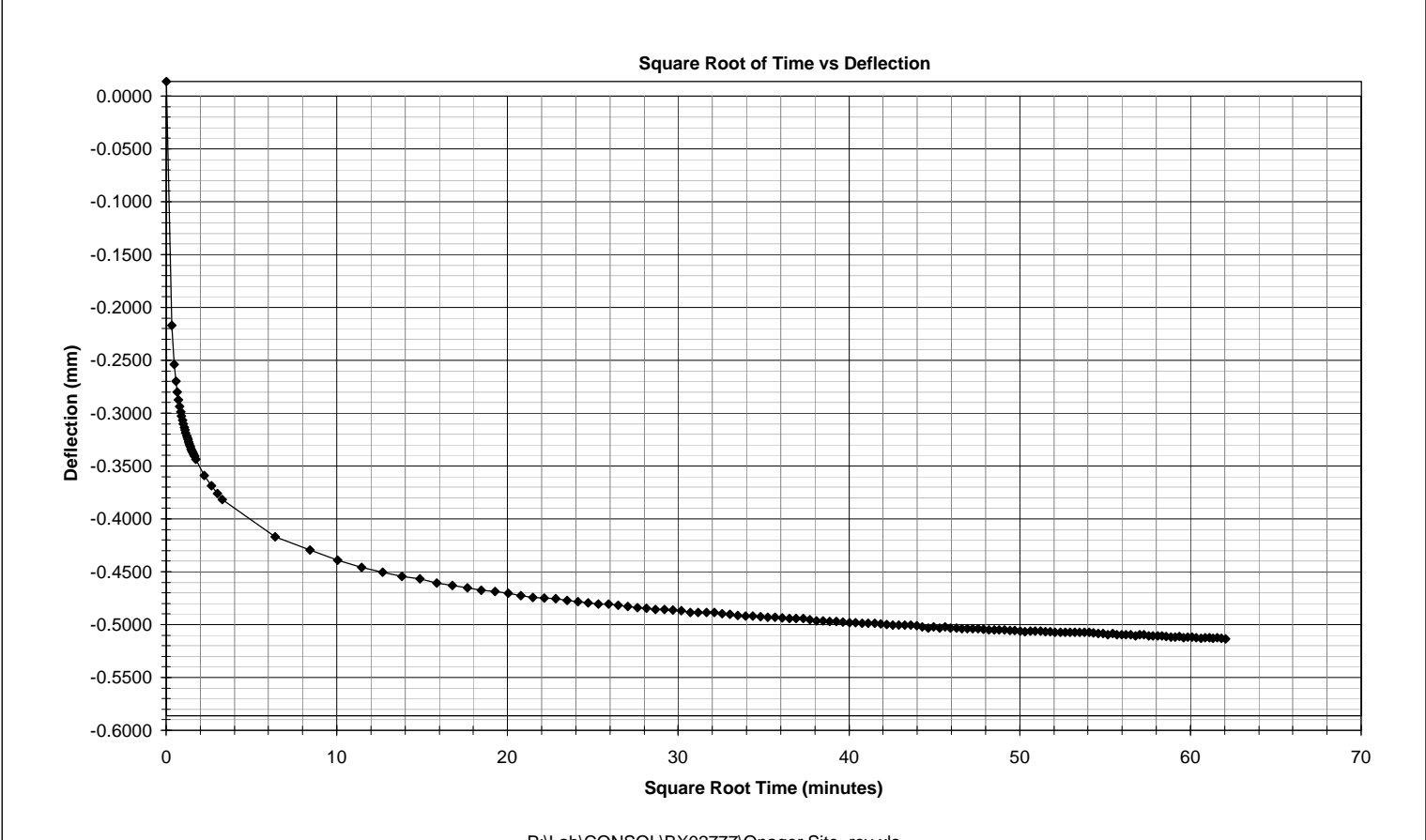
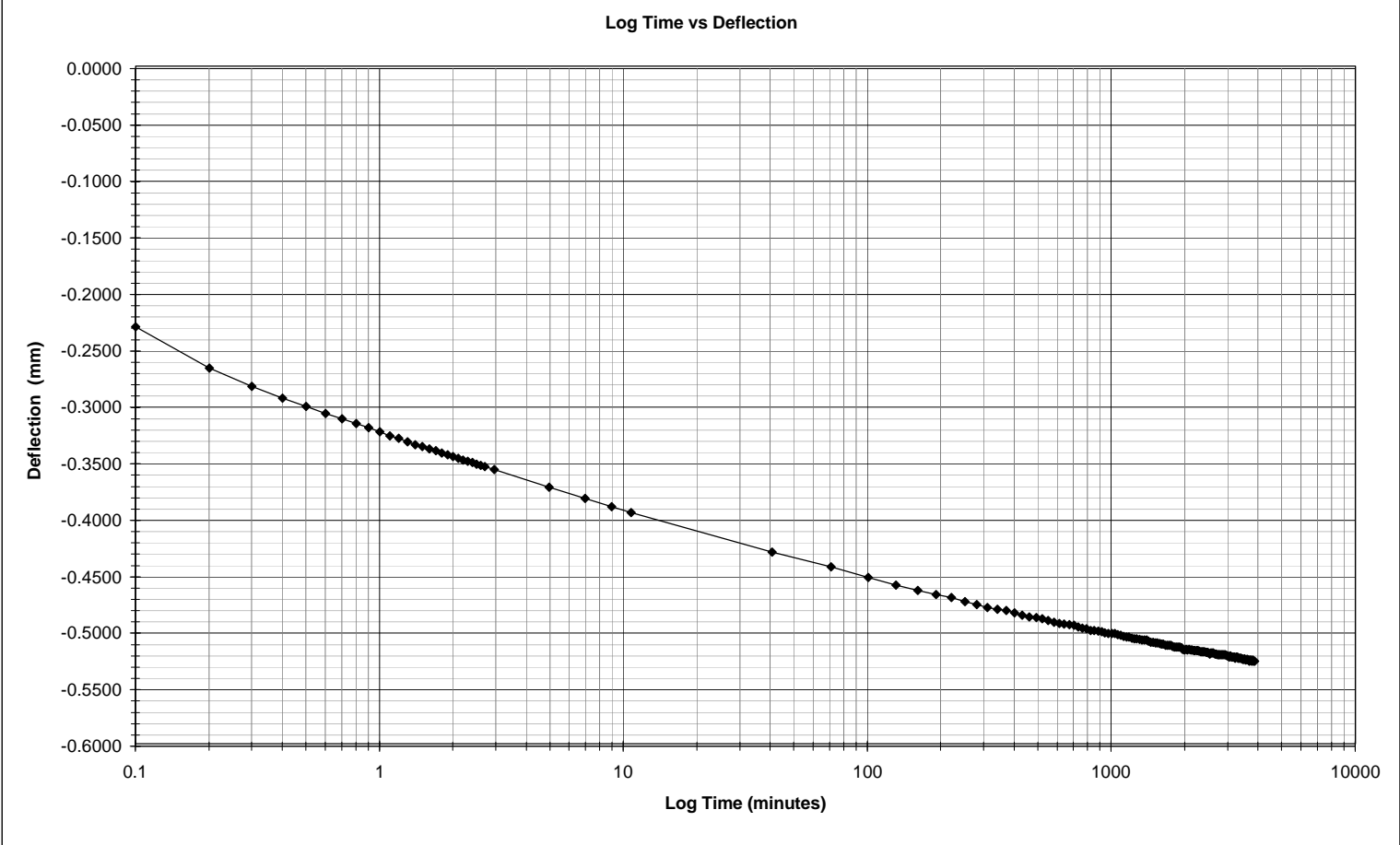
AMEC EARTH & ENVIRONMENTAL LIMITED <i>Engineering & Environmental Services</i> ONE-DIMENSIONAL CONSOLIDATION TEST (ASTM D2435-90)	Project	Defence Research Development Canada		
	Location	Medicine Hat, AB		
	Job No.	BX02777	Sample No.	Machine # 7
	Hole No.	Onager Site	Depth (m)	-
	Technician	LK	Loading Date	12/11/2003
	Loading Stage	382.58 kPa	Start Loading Time	9:39:34



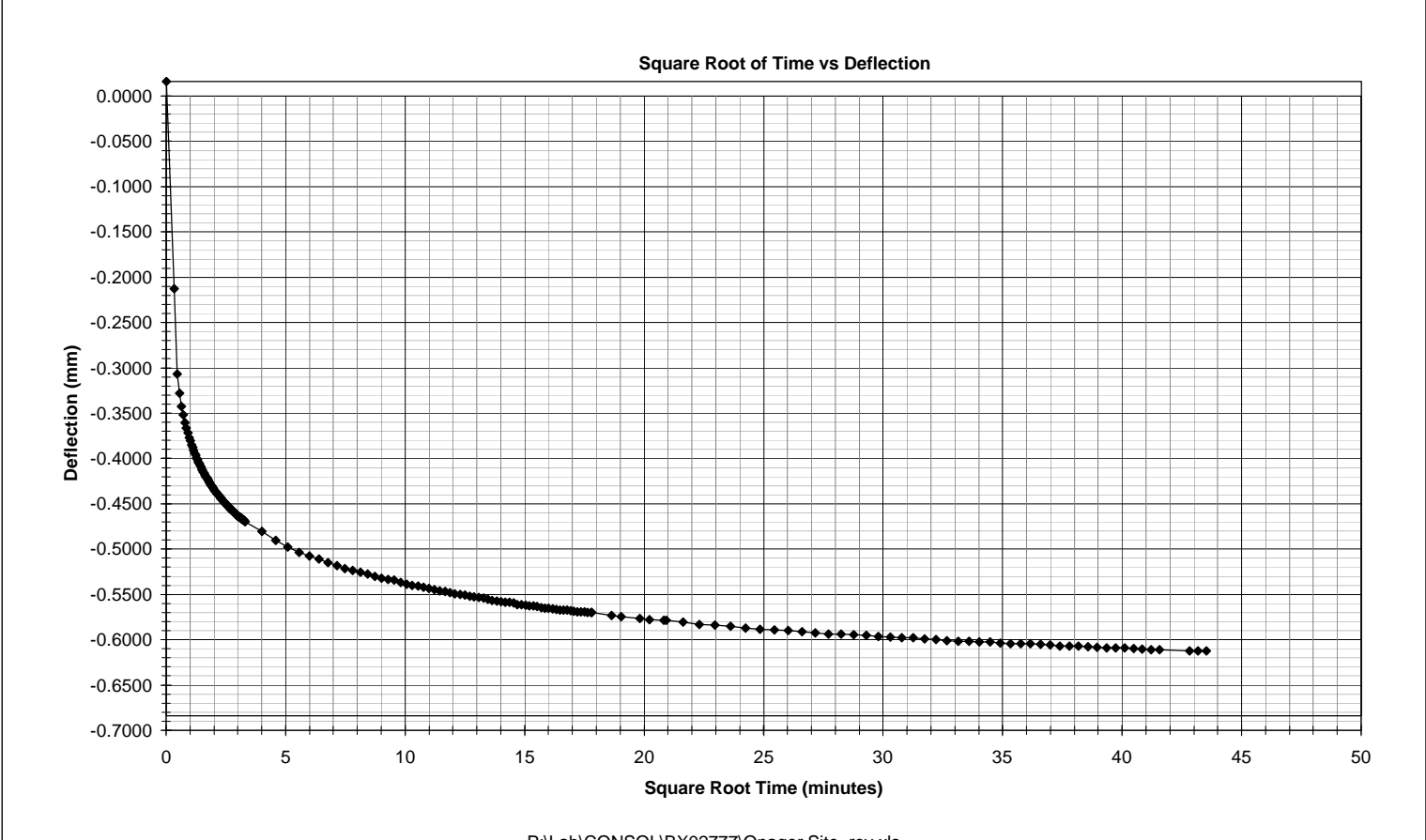
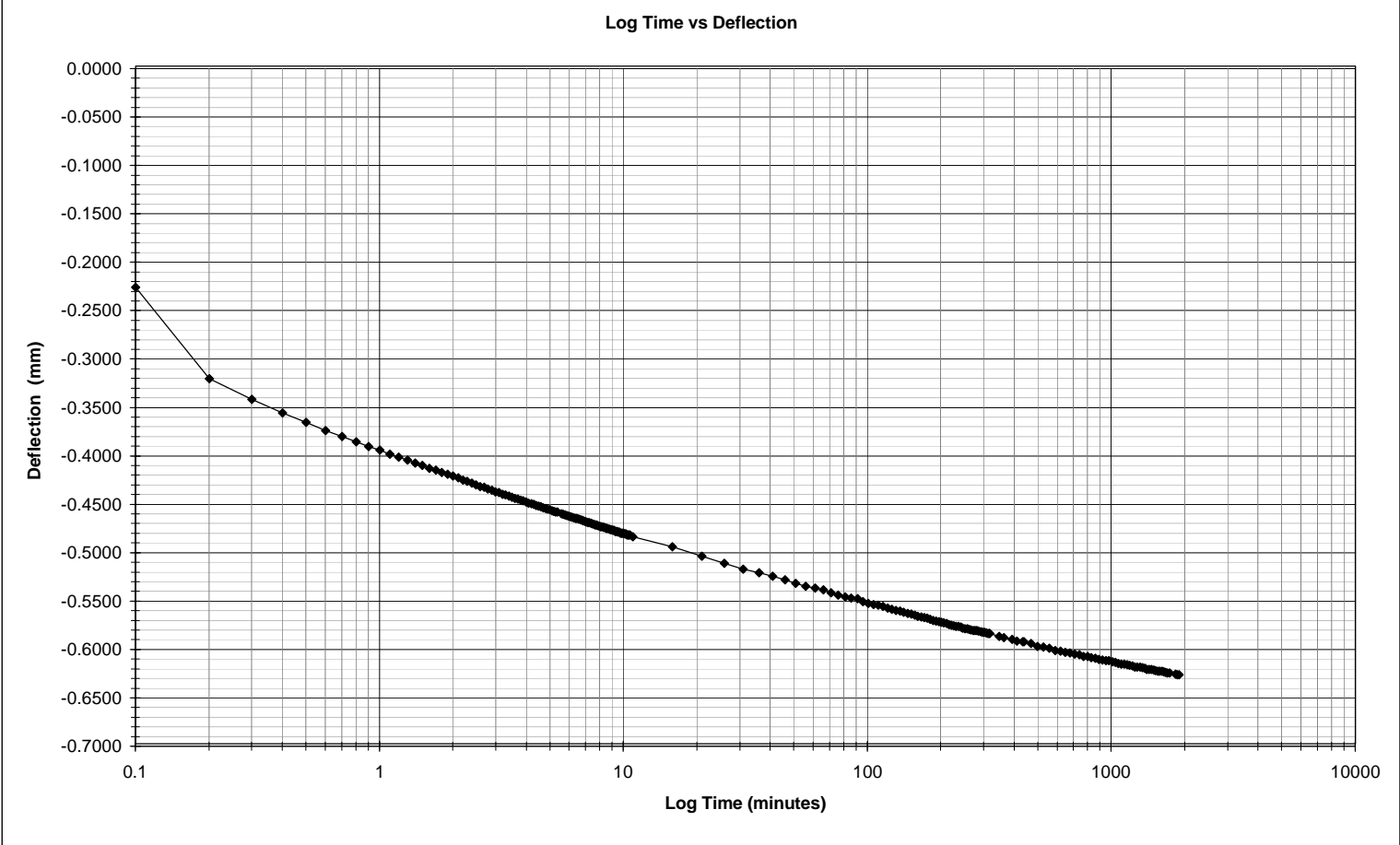
AMEC EARTH & ENVIRONMENTAL LIMITED <i>Engineering & Environmental Services</i> ONE-DIMENSIONAL CONSOLIDATION TEST (ASTM D2435-90)	Project	Defence Research Development Canada		
	Location	Medicine Hat, AB		
	Job No.	BX02777	Sample No.	Machine # 7
	Hole No.	Onager Site	Depth (m)	-
	Technician	LK	Loading Date	13/11/2003
	Loading Stage	764.04 kPa	Start Loading Time	11:55:21



AMEC EARTH & ENVIRONMENTAL LIMITED <i>Engineering & Environmental Services</i> ONE-DIMENSIONAL CONSOLIDATION TEST (ASTM D2435-90)	Project	Defence Research Development Canada		
	Location	Medicine Hat, AB		
	Job No.	BX02777	Sample No.	Machine # 7
	Hole No.	Onager Site	Depth (m)	-
	Technician	LK	Loading Date	14/11/2003
	Loading Stage	1527 kPa	Start Loading Time	17:35:08 PM



AMEC EARTH & ENVIRONMENTAL LIMITED <i>Engineering & Environmental Services</i> ONE-DIMENSIONAL CONSOLIDATION TEST (ASTM D2435-90)	Project	Defence Research Development Canada		
	Location	Medicine Hat, AB		
	Job No.	BX02777	Sample No.	Machine # 7
	Hole No.	Onager Site	Depth (m)	-
	Technician	LK	Loading Date	17/11/2003
	Loading Stage	3034.8 kPa	Start Loading Time	10:25:03



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AMEC Earth & Environmental Limited (AMEC) was retained by Defence Research & Development Canada (DRDC) Suffield to carry out laboratory testing on soil samples from prairie soil samples from the Mine Effects Site near Building 148 on the Experimental Proving Ground at DRDC Suffield. AMEC's geotechnical laboratory in Edmonton, Alberta received three large, bag soil samples in late October 2003 for DRDC's Piston, Onager East and Onager West sites.

The following laboratory tests were requested by DRDC:

1. · Determination of water content of soil samples;
2. · Preparation of compacted samples in range of natural water contents;
3. · Consolidation tests using ASTM D2435 on two samples; and
4. · Triaxial undrained tests (CUP) using ASTM D4767 on three samples.

A typical range of natural water contents of 13 to 19 percent was provided to AMEC by DRDC Suffield for similar soil at these sites. For testing, compacted samples were prepared at water contents within the natural water content range, with target water contents of approximately 15 percent.

Results are provided according to American Standard Testing Methods (ASTM) standards where applicable. Results for the Triaxial undrained tests (CUP) using ASTM D4767 on three samples are provided in CR 2004-138, DRDC Soil Laboratory Program Triaxial Test Results – Onager Site.

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soil samples
water
compaction
Consolidation
Triaxial undrained